DEC 1 1928

VOL. 55 NOVEMBER, 1928 No. 8

BULLETIN
OF THE
TORREY BOTANICAL CLUB

Editor
TRACY ELLIOT HAZEN

Associate Editors
Albert Francis Blakeslee
Cornelia Lee Carey
Frank Earl Denny
Alexander William Evans
Henry Allan Gleason
Alfred Gundersen
George Tracy Hastings
Marshall Avery Howe
Louis Otto Kunkel
Michael Levine
Sam F. Trelease
Arlow Burdette Stout

CONTENTS

Edward Sandford Burgess (1855–1928) (portrait) ..... MARSHALL AVERY HOWE 433
Contributions to the Mesozoic flora of the Atlantic coastal plain—XV (plates 11, 12) ..... EDWARD W. BERRY 441
Pollen grains in the identification and classification of plants—II. Barnadesia (plate 13) ..... R. P. WODEHOUSE 449
Notes on southeastern woody plants ..... W. W. ASHE 463
INDEX TO AMERICAN BOTANICAL LITERATURE 467

PUBLISHED FOR THE CLUB MONTHLY
EXCEPT JULY, AUGUST AND SEPTEMBER

BY

GEORGE BANTA PUBLISHING COMPANY
MENASHA, WISCONSIN

SUBSCRIPTION PRICE PER YEAR $4.00

Entered as Second Class Matter at the Post Office at Menasha, Wisconsin.

TORREYA

A bimonthly journal of botany

Articles on the local flora, non-technical accounts of common plants of all groups, botanical notes, book reviews, etc.

Published by the Torrey Botanical Club at $1.00 a year. Address the treasurer,

MRS. HELEN M. TRELEASE
Box 42, Schermerhorn Hall, Columbia University, New York City

THE BRYOLOGIST

PUBLISHED BY THE

SULLIVANT MOSS SOCIETY

The only magazine in English devoted wholly to Mosses, Hepatics, and Lichens. Bi-monthly; amply illustrated; for beginners as well as for advanced students. Yearly subscriptions, $1.25. Address

A. TENNYSON BEALS, 2925 BROADWAY, NEW YORK CITY

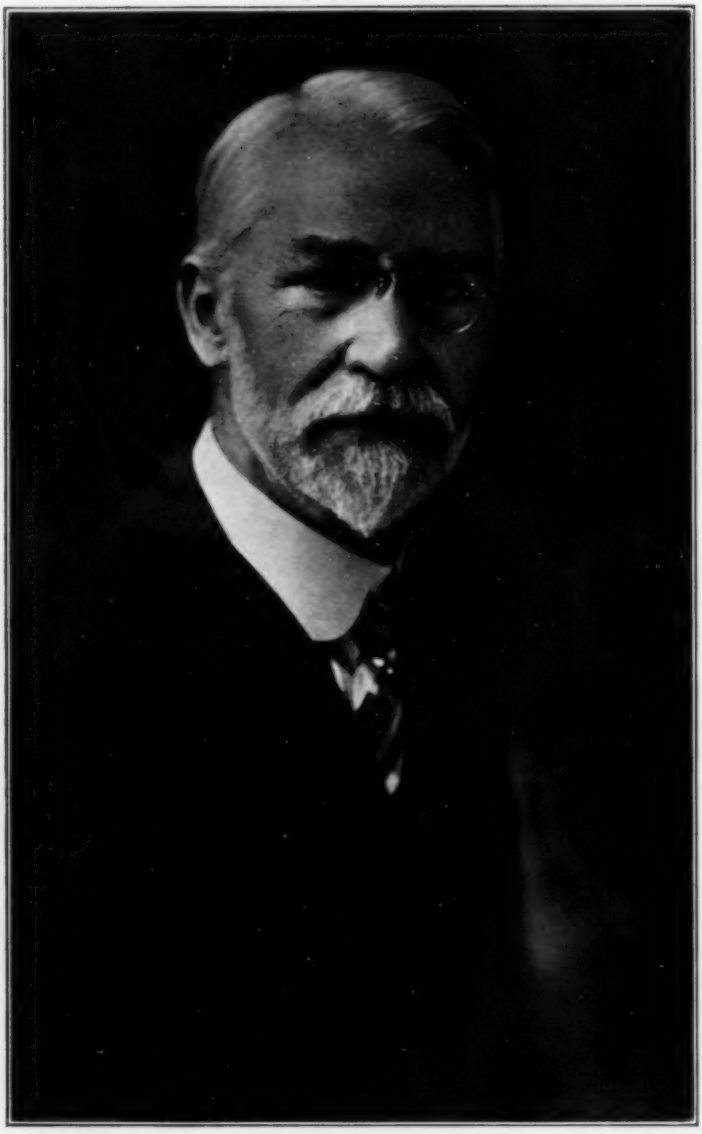
BIOLOGY SUPPLIES

Dissecting Instruments	Chemicals and Stains
Microscopes and Accessories	Microscope and Lantern Slides
Models and Charts	Naturalists' Supplies
Laboratory Glassware	Skeletons

Catalogues applying to any of these articles in which you are interested will be sent on request.

NEW YORK BIOLOGICAL SUPPLY CO.
General Supplies for the Biological Sciences
34 UNION SQUARE NEW YORK CITY

Please mention the BULLETIN *when answering advertisements*



Cordially yours
Edward S. Burgess

UNIV. OF MICH.

Edward Sandford Burgess

(1855–1928)

(WITH PORTRAIT)

MARSHALL AVERY HOWE

Educational and scientific circles in New York City have been left distinctly poorer by the passing of Professor Edward Sandford Burgess, for many years head of the department of biological sciences in Hunter College. And his high repute as a scientist and his inspiring influence as a teacher and as a man have extended far beyond the confines of the American metropolis.

Edward S. Burgess was born in Little Valley, Cattaraugus County, New York, January 19, 1855, and his death, after a brief illness, occurred in New York City, February 23, 1928. Dr. Burgess enjoyed the priceless heritage of refinement, high character, and intellectual interests, and he personified the best results of 'gentle breeding.' His grandfather, Dr. Jacob Burgess, was one of the early settlers of Silver Creek, Chautauqua County, New York, coming from Berkshire County, Massachusetts, in 1811. His father, the Reverend Dr. Chalon Burgess, was for a long time pastor of the Presbyterian Church at Silver Creek. His mother, Emma Johnston, was the daughter of the Reverend Charles Johnston, a Congregational clergyman, of Ovid, Seneca County. A brother, Dr. Theodore Chalon Burgess, was a teacher of classics and was for many years President of the Bradley Polytechnic Institute of Peoria, Illinois. A sister, Miss Julia Burgess, is Professor of English in the University of Oregon.

Dr. Burgess was graduated from the State Normal School at Fredonia, New York, and in 1879, with high distinction, from Hamilton College. That his interest in plants began early is seen by his publication of a note on '*Preissia commutata*' in the Bulletin of the Torrey Botanical Club for September,

[THE BULLETIN FOR OCTOBER (55:327–432) WAS ISSUED 25 OCTOBER 1928.]

1875, the month that he entered college. This Marchantiaceous hepatic, now known as *Preissia quadrata*, is reported as occurring in Panama Ravine, N. Y., the third definitely recorded station for that species in the United States up to that time. A remarkable work for a youth of his years is his 'The Chautauqua Flora,' listing 880 species of plants of Chautauqua County and dated 'Clinton, N. Y., 1877,' two years before his graduation. This was not printed, but copies were made by some manifold process. After teaching botany in the Delaware Literary Institute at Franklin, New York, for one year, he went in the autumn of 1880 to The Johns Hopkins University for graduate study in Greek under the distinguished classical scholar, Dr. Basil Gildersleeve, and during the next university year, 1881–82, he held a fellowship in Greek in that institution. His ardent love of nature, leading him from early boyhood into habits of closest observation, influenced, however, his decision to make the teaching of science his life work. In 1882, we find him as teacher of botany and other natural history subjects in the Central High School of Washington, D. C., a post he held for fourteen years. From 1881 to 1895 inclusive he was Professor of Botany in the Martha's Vineyard Summer Institute, reputed to have been the first summer school in this country after that of Agassiz on the island of Penikese. In 1885, he also gave instruction in botany in The Johns Hopkins University.

In the autumn of 1895, Dr. Burgess began his new and, as it eventuated, his main work, as Professor of Natural Science in Hunter College, then the Normal College. It is of interest to note that he was elected a member of the Torrey Botanical Club on April 9, in advance of his coming to New York, though doubtless in anticipation of such a move. In January, 1897, he was elected Recording Secretary of the Club, a position that he filled with much distinction for six years. The proceedings of the Club, as recorded by him during those years, are models of scientific accuracy, wealth of detail, and beauty of English diction. In 1900, he contributed an interesting and valuable account of the history of the Club to the program of 'Torrey Day' held at The New York Botanical Garden on June 27, in Connection with meetings of the Botanical Section of the American Association for the Advancement of Science. During the years of 1912 and 1913, he served ably as the Club's president,

a post that made him *ex officio* one of the Scientific Directors and a member of the Board of Managers of The New York Botanical Garden, in connection with which his counsel was highly appreciated by his associates.

Although primarily a botanist, Dr. Burgess had broad interests in science in general, and was, perhaps, one of the last representatives of the 'old school naturalist.' In this connection the recent words[1] of Dr. Walter K. Fisher, Director of the Hopkins Marine Station of the Leland Stanford Junior University, seem most fitting:

'In our strenuous era of high pressure research, when beginners emerge from courses in test-tube biology—*à la mode* and labeled "modern"—with a somewhat cynical and suspicious attitude toward Nature in her visible forms, it is perhaps permitted one to reflect upon the passing of the fine art of instilling an appreciation of natural history, and to wonder if youngsters of the future will experience the intellectual high adventure which has been the good fortune of those who have walked with Henslow, Agassiz, Jordan, Dudley, Burgess, Comstock, and many another of the past or passing generation.'

Next to botany, the chief scientific interest of Dr. Burgess was doubtless in the field of anthropology, in which he left two unpublished manuscripts. A published work of great charm, dealing largely with the Indian lore of Martha's Vineyard, is entitled 'The Old South Road of Gay Head, or Musings on Discontinued Byways.' The broad sweep of his mind included also studies of technical and popular names of plants, paleontology, genealogy, and evidences of human descent. His collecting instincts embraced not only plants, but also Greek glass, Greek vases, Chinese and Japanese porcelain, pottery, basketry, and implements of primitive peoples, Keatsiana, Shelleyana, autographs, etc. One of his minor activities was to prepare the definitions of the botanical genera, tribes, and families for the Century Dictionary, M to Z.

It is as an intensive and critical student of the genus *Aster* that the memory of Dr. Burgess will endure among botanists. His attention was directed to this difficult genus in a special

[1] Science II. 67: 502. 18 My 1928.

way as early as 1886. The genus *Aster*, as is widely recognized, is a group of extremely variable plants, one in which species are very difficult to define or are perhaps non-existent according to the older more rigid definitions of the species concept. Dr. Asa Gray, towards the end of his career, remarked of it that 'little satisfaction has been obtained as a result of prolonged and repeated studies.' It was to such a group that Dr. Burgess, lured by the possibility of finding here the forces of evolution still actively at work, turned his powers of accurate observation and his tenacity of purpose. He reached the conclusion that there existed in nature a reliable basis for the recognition of many more species than previous students of the group had been willing to admit. In his monograph entitled 'Species and Variations of Biotian Asters, with a Discussion of Variability in Aster,' which constitutes volume 13 of the Memoirs of the Torrey Botanical Club—a volume of 419 pages, with 13 plates and 108 text figures—he recognizes and describes in the section Biotia 84 species in place of the 2 to 11 recognized by preceding writers. In defense of this position, which some have considered radical and unwarranted, he says:

'Many of the species here first published have been watched in their natural environment for periods varying from seven to ten years; and without change of characters. I have not spared expense or time or travel, while keeping selected plant-colonies under repeated observation, in widely separated localities, in New England, about Lake Erie, the Hudson Valley, and the Potomac. I have called on each form to show its permanence while in unaltered natural conditions before according it the rank of an independent species. I have often held back some remarkable form from specific recognition (as I still do the obolarian form, p. 113) with the thought that it must surely be but a passing phase of the species, induced by the particular environment; only as often to meet the same form again in a new and distant locality, presenting not only the same characteristics possibly due to environment, but presenting also identical additional characters apparently not connected with environment at all. In such cases I have thought it better to describe such a type as a distinct species. How cautious I have endeavored to be may be seen from the number, some 250, of plant types under observation which are listed here merely as indeterminate forms, most of which

represent not casual specimens but forms which I have followed up year after year.'

The limitations of species in certain genera may always remain largely a subjective matter, but whether one considers Burgess's numerous species of *Aster* and his more numerous characterized nameless forms to be 'species,' 'varieties,' 'forms,' 'subforms,' or 'mutants,' the incontestable fact remains that he has made a permanent record of a vast number of actually existent phenomena—a record that must be of great service to any future student of the genus *Aster*.

The publication of the monograph on the Biotian Asters was preceded by the appearance of the erudite 'History of Pre-Clusian Botany in its Relation to Aster,' which constitutes volume 10 of the Memoirs of the Torrey Botanical Club. In this notable work, Dr. Burgess's mastery of the classical languages finds full play. He traces back the use of the name *Aster* as applied to a plant more than 2200 years and stops with Clusius (1526–1609) because that distinguished master of botany began a new era in the history of *Aster* by defining clearly several species where only one had been recognized before. While Professor Burgess was engaged in these historical researches and in preparing his monograph, he found time to assist actively in writing the text of the treatment of the genus *Aster* in the Britton & Brown, *Illustrated Flora of the Northern United States, Canada, and British Possessions*, and he did likewise for Britton's *Manual of the Flora of the Northern United States and Canada*. A little later he contributed the account of the genus *Aster* to Small's *Flora of the Southeastern United States*.

In 1899 Professor Burgess received the degree of Ph.D. from Columbia University, and in 1904, the honorary degree of Sc.D. from Hamilton College. He was a member of Phi Beta Kappa, the New York Academy of Sciences, the American Anthropological Association (a founder), the American Folklore Society, the American Association for the Advancement of Science, The New York Botanical Garden, the Botanical Society of America, and the Century Association, in addition to the Torrey Botanical Club.

Professor Burgess bequeathed his collection of Asters to The New York Botanical Garden, his plants of Martha's Vineyard to the Dukes County [Massachusetts] Historical Society, and his general herbarium to Hunter College.

This brief sketch of the career of Edward Sandford Burgess would be sadly incomplete without some reference to his home life and this phase of our subject is beautifully covered by the following paragraph[2] from the pen of Dr. Walter K. Fisher:

'Dr. Burgess's friends will cherish most the memory of him in his Yonkers home, Sweetbriarside. His marriage to Irene S. Hamilton, of Fredonia, N. Y., was one of rare companionship of spirit. Their garden, with its Shakespeare plot, its Wordsworth bed, its Keats corner, its Hellenica, its plants of western New York, its lily pool filled with native and exotic lilies, its dozen varieties of hybrid sweetbriars, its eighty or more different conifers, its wealth of tulips and roses, has been a delight to all flower-lovers and is the expression of the lifelong devotion of its owners.'

In June, 1925, when, after thirty years of faithful and efficient service as head of the department of the biological sciences in Hunter College (and, for a time, acting president), Professor Burgess retired from active duty, the following tribute was offered to him, by one long familiar with his work:

'In grateful recognition of thirty years of distinguished service to science, to the cause of higher education, and in particular to Hunter College, New York City, and to the thousands of young women who have studied there, this tribute is offered to

DOCTOR EDWARD SANDFORD BURGESS
PROFESSOR AND HEAD OF THE DEPARTMENT OF BIOLOGY AND SOME TIME ACTING PRESIDENT

An organizer and executive of marked ability, a gifted and inspiring teacher, a model of devotion to duty, a master of his subject and a thorough scholar in many other fields, a man inspired by the highest ideals and responsive to all the finer and nobler things of life, beloved and admired by his pupils

[2] Science II. 67: 502. 18 My 1928.

and associates, his services cannot be measured, for they have become a part of the lives of all who know him. He has given of his best, and a best far above the average, and he also receives of the best—the consciousness of high service nobly done. Could all those who have been made better by his presence, influence, and example give adequate expression to their appreciation, it would be as a fadeless garland in which the laurel of victory is entwined with the roses of love.'

After the passing of Professor Burgess, Dr. George S. Davis, President of Hunter College since 1908, wrote these appreciative words:

'We all feel his loss. Hunter College knew him as the most scholarly member of its faculty: a scientist of the highest rank, an acknowledged authority in his special field. With all this, he was a man unselfishly devoted to the work of education, a man of liberal mind and a most courteous gentleman.'

Publications of Professor Burgess

Preissia commutata. Bull. Torrey Club **6:** 55. S 1875.

The Chautauqua flora: a catalogue of the plants of Chautauqua Co., New York, native or naturalized; extending through the cryptogamous plants to the end of the Hepaticae. pp. 1–37. Clinton, N. Y. 1877. [Not printed; a limited edition by some kind of 'manifold' process.]

Washington High School. Syllabus of the courses in botany and zoology, Sept. 1883-June, 1884. pp. 1–39. No date. [1883?]

Washington High School. Guide to the student in botany. pp. 1–44. No date. [Copyright, 1887.]

Washington High School. Outline of the first year course in natural science, 1887–1888. pp. 1–44. No date. [Copyright 1887.]

The work of the Torrey Botanical Club. Bull. Torrey Club **27:** 552–558. 26 O 1900.

The fairylore of flowers. Jour. N. Y. Bot. Gard. **1:** 161–168. N 1900. [Abstract of a lecture.]

The influence of flowers upon literature. Jour. N. Y. Bot. Gard. **2:** 97–105. Jl 1901. [Abstract of a lecture.]

Plant illustration in the Middle Ages. Torreya **2:** 60–61. 12 Ap 1902.

History of pre-Clusian botany in its relation to Aster. Mem. Torrey Club **10:** i–xi+1–447. 22 N 1902.

Aster. In: Small, J. K. Flora of the Southeastern United States 1206–1228. 22 Je 1903.

Species and variations of Biotian asters, with a discussion of variability in Aster. Mem. Torrey Club **13:** i–xv+1–419. *pl. 1–13+f. 1–108*. 15 Mr 1906.

A method of teaching economic botany. Mem. Torrey Club **17**: 52–55. 10 Je 1918.

The old south road of Gay Head or musings on discontinued byways. Dukes County [Mass.] Historical Soc. Publ. **1**[4]: 1–35. O 1926.

Contributions to the Mesozoic flora of the Atlantic coastal plain—XV

EDWARD W. BERRY

(WITH PLATES 11, 12)

In the fourteenth contribution of this series,[1] published in 1921, an account was given of the extensive Upper Cretaceous floras, chiefly from Henry and Carroll counties in the coastal plain of western Tennessee, which in late Upper Cretaceous time were entombed in the littoral deposits of the Mississippi embayment.

The Ripley formation, the latest known Cretaceous in the Mississippi embayment, was found to contain 135 species of fossil plants which were fully described and figured by the writer in 1925,[2] and the types were subsequently deposited in the United States National Museum.

The bulk of this earlier material came from but two localities —the Perry Place in Henry County and the Cooper Pit in Carroll County. Each of these localities furnished 66 species, and of these 117 species only 15 were common to the two localities. At the time this contrast in facies of the two florules was attributed to the inevitable accidents of preservation and discovery in the case of fossils of all kinds rather than to environmental or age differences, since at both localities the sediments were similar, and the detailed mapping showed both to represent practically the same horizon. This negative factor, entirely fortutious, is one that is frequently lost sight of by paleontologists dealing with all classes of fossils, and it is a factor that should always be given due weight in comparisons of collections from different localities.

The writer recently received a small collection from the Cooper Pit in Carroll County, made by R. Lee Collins, which contained a number of specimens of interest and which helped substantiate the preceding statement. It is this collection which is the subject of the present contribution.

[1] Bull. Torrey Club **48:** 55–72. 1921.

[2] U. S. Geol. Survey Prof. Paper 136: 1–94. *pl. 1–23.* 1925.

The following 15 species of plants, as well as an interesting type of Cretaceous fish scale, are represented by finely preserved material:

Antholithes ranaliformis n. sp.
Capparis proeocenica Berry
Celastrophyllum Ripleyanum Berry
Gleichenia delicatula Heer
Mimusops Collinsi n. sp.
Moriconia cyclotoxon Debey & Ettingshausen
Muscites (?) Lesquereuxi n. sp.
Myrica ornata Berry
Myrica Torreya Lesquereux
Myrica Wadii minor Berry
Nectandra prolifica Berry
Potamogeton hydrocharitoides (Berry)
Raphaelia minuta Berry
Raphaelia neuropteroides Debey & Ettingshausen
Zizyphus Ripleyensis Berry

Of these 15 species those new to science are indicated in the foregoing list. In addition to these three, *Gleichenia delicatula* Heer is new to the Ripley flora, and *Capparis proeocenica* and *Myrica Wadii minor* are new to this locality and were formerly known only from the Perry Place in Henry County. When a very small collection such as this furnishes four additions to a fairly well known flora and includes three new species, it shows that the accidents of preservation and discovery are most important factors in our efforts to picture the floristics and ecology of the past.

There follow comments on those species that seem to demand discussion.

Muscites (?) Lesquereuxi Berry, n. sp.

(Plate 11, figs. 1–3)

Selaginella laciniata Berry, U. S. Geol. Survey Prof. Paper 136: 25. 1925 (not Lesquereux 1875).

Lesquereux, followed by Knowlton, recorded two small forms of *Selaginella* from what is now called the Mesaverde formation at Point of Rocks, Wyoming. Both authors clearly recognized that the reference to *Selaginella* was highly doubtful. In my account of the Ripley flora I referred fragmentary specimens from the Cooper Pit to one of these species—*Selaginella laciniata*—not changing the generic reference because of its correlation value, but pointing out that I considered its reference to *Selaginella* 'entirely without foundation.'

Study of the new material has shaken my belief that the Ripley form is the same as that from Wyoming. The material is thoroughly carbonized and shows no structural details. I am sure that neither it nor the Wyoming material represents *Selaginella*, and that the former probably represents some moss. In the case of that from the Ripley, of which the accompanying figures give an excellent idea, I have tentatively referred it to the form genus *Muscites* as more likely to represent its botanical affinity.

RAPHAELIA MINUTA Berry

(Plate 11, fig. 4)

Raphaelia minuta Berry, U. S. Geol. Survey Prof. Paper 136: 26. *pl. 1. f. 5–7.* 1925.

This beautiful little specimen is clearly conspecific with what I described from this locality under the above name. It is clearly filicean, but its generic affinities are entirely obscure.

RAPHAELIA NEUROPTEROIDES Debey & Ettingshausen

(Plate 11, fig. 6)

This interesting specimen represents the terminal part of a pinna of this species from which the lamina has entirely disappeared, leaving only the vascular system. Normal specimens occur in the Ripley at both the Henry and Carroll County localities.

The type material came from Rhenish Prussia, and was very fragmentary and probably composite, but the Tennessee material agrees exactly with material from the Patoot beds of western Greenland that Heer [3] identified with the European type.

GLEICHENIA DELICATULA Heer

(Plate 11, fig. 5)

Gleichenia delicatula Heer, Fl. Foss. Arct. 3^2: 54. *pl. 9. f. 11e; pl. 10. f. 16, 17.* 1874.

The specimen figured on the accompanying plate agrees perfectly with the type of this species, which was described by Heer from the Kome beds of western Greenland. This author recorded 15 so-called species of *Gleichenia* from the

[3] Heer, O. Fl. Foss. Arct. **7**: 6. *pl. 60. f. 3, 3b.* 1883.

Kome beds, seven from the Atane beds, and three from the Patoot beds—all in a very circumscribed area—or 19 species in all. Not only are many of these based upon fragments showing but slight differences in form or venation, but subsequent visitors to the region have found difficulties in drawing boundaries between these beds, and in some cases at least the original age determinations are obviously erroneous. All that can be said is that *Gleichenia* was abundant in Greenland throughout the whole Cretaceous and was represented by several species.

Not only are several of Heer's species indefinable and unrecognizable, but subsequent students in different parts of the world have used first one and then another of Heer's names for equally fragmentary and not certainly determinable remains.

The Ripley specimen is a fragment of a long slender linear pinna, preserved for a length of 4 cm., with short, wide, rounded segments. Many of the nominal species in the literature show very similar features, particularly in their smaller pinnae or in the distal parts of pinnae. What has been considered to represent the present species has been recorded by Velenovsky from Bohemia, by Knowlton from the Cumberland Coal field in Wyoming and the Vermejo formation in Colorado, and by the writer from the Raritan formation of New Jersey and the Tuscaloosa formation of Alabama. Very little reliance can be placed upon these records as conclusively indicating the range of a single botanical species.

The Ripley specimen is sterile, and its coriaceous character partially obscures the venation, but I have not the slightest doubt that it represents a *Gleichenia*. It adds a new element to the Ripley flora, one of considerable interest from the standpoint of correlation and ecology, confirming previous comparisons with our western interior Cretaceous, where there is a scattered representation of *Gleichenia* up to and including the Montana group, but no known records from the Laramie. Nor is the genus certainly known from any later horizons in the United States.

The present specimen is distinctly different from *Asplenium calopteris* (Debey & Ettingshausen) Heer, which was previously recorded from this locality. It is, however, much like what Debey & Ettingshausen described from the sands of Aix-la-Chapelle as *Didymosorus comptoniifolius*, and which Heer

transferred to *Gleichenia*, and thus adds another element to the Ripley flora that suggests an age similar to that of the classic European Cretaceous flora of Aix-la-Chapelle (Aachen).

Moriconia cyclotoxon Debey & Ettingshausen

(Plate 11, figs. 10–12)

Despite the fact that this species has been known since 1859, and its abundance at certain localities, only the vegetative twigs have been discovered, and consequently its systematic position remains uncertain.

It is abundant at the Cooper Pit, and some of the collected specimens illustrate features not previously observed, and point to the validity of the associated *Moriconia americana* Berry, which has been disputed by Kräusel. The species is known to be variable, particularly with respect to the size and the degree of elongation of the lateral twigs and the unequal development of the latter. In the present material may be noted the branching of lateral axes from the axils of normal lateral twigs, at least we observe branched forms like the specimen figured (fig. 11) and others with undeveloped laterals in the axils of normal laterals.

The longer specimen shown (fig. 12) well illustrates the fern-like appearance of twigs in which concrescence has not taken place and the substance is therefore thin and the leaf outlines indistinct. This specimen is apparently an immature twig. The marginal leaves differ strikingly from the facial leaves in being drawn out into cuspidate and often incurved points; and at the tips of the laterals, as shown in the enlarged sketches, several cycles of marginal leaves are visible distad of the youngest facial leaves, showing that the former were more precocious. If these be compared with twigs of *Moriconia americana*, in which the apical leaves are always reduced[4] the two are seen to be very dissimilar, *Moriconia americana* having rapidly narrowing and short lateral twigs, with all of the leaves blunt and the apical leaves always facial instead of marginal leaves.

[4] See, for example: Berry, U. S. Geol. Survey Prop. Paper 84: *pl.* 7. *f.* 1–4. 1914; 136: *pl.* 3. *f.* 3, 4. 1925.

POTAMOGETON **hydrocharitoides** (Berry)
(Plate 12)

Phyllites hydrocharitoides Berry, U. S. Geol. Survey Prof. Paper 136: 88. *pl. 22. f. 9.* 1925.

This form was partially described from incomplete material and was referred to *Phyllites* with the suggestion that it represented some member of the Hydrocharitaceae or Potamogetonaceae. The new material, which is much more complete, is so like various existing members of *Potamogeton* that I have transferred it to that genus.

The stems are long and lax, decidedly flattened but with an apparently central vascular strand. Unbranched lengths of as much as 13 cm. have been observed. The specimen figured is somewhat obscured by the abundance of superimposed branches and leaves. The so-called bracts or stipules are lanceolate, 6 or 7 mm. long and up to 2 mm. in maximum width. The leaves are long, flat, slender, and very lax.

The species shows some resemblance to *Zannichellia* and *Ruppia*, and is practically identical with various existing submerged species of *Potamogeton* in which the leaves are very slender and lax. Among these I may mention *P. pectinatus* Linnè, *P. filiformis* Persoon, *P. foliosus* Rafinesque, *P. trichoides* Chamisso & Schlecht., etc. These modern species are all widely distributed and often marine. *P. pectinatus* is found in Asia, Africa and Australia; *P. trichoides* in Europe, Asia, and Africa; *P. filiformis* is typically marine in shallow coastal waters on sandy bottoms, and is found in Europe, Asia, Africa, Australia and North America; *P. foliosus* occurs widely in North America and in Hawaii.

The genus *Potamogeton* contains over 100 species, of which about 40 are extinct and about 60 existing, the latter mostly of wide geographical range. The fossil record extends from the Upper Cretaceous to the Recent and the foliar remains, of which there is a second characteristic species in the Ripley flora, are frequently corroborated by being associated with characteristic fruits.

Antholithes ranaliformis Berry, n. sp.
(Plate 11, figs. 7–8)

Flower regular, solitary, 2.1 cm. in diameter; with five large obovate sepals or petals, 9 mm. long and 6 mm. in maximum

width. The central part is indistinct, but relatively large, and its counterpart shows a mass of small objects, mostly poorly preserved, of which two or three are distinctly like free pistils with short recurved styles in a capitate head. Traces of numerous free stamens are preserved; they are about half as long as the petals (?), and some retain relatively small two-celled anthers. The central part showing the traces of the pistils and the styles is shown in the enlarged sketch (fig. 8).

This fine specimen is clearly referable to the family Ranunculaceae, and is, in all of its features, like the flowers of such familiar genera as *Caltha*, *Trollius*, *Anemone*, *Ranunculus*, etc. The original and counterpart are preserved in fine grained clay, and although it cannot be determined whether the floral envelopes represent sepals or petals, the impression might well be a large buttercup or anemone, and this family shows much variability in the presence or absence of petals, and the petaliferous development of the sepals where the petals are wanting.

None of the associated foliar remains suggest any relationship with this flower.

Mimusops Collinsi Berry, n. sp.

(Plate 11, fig. 13)

Leaves of medium size, sphenoidal in general outline, widest at the tip of the midvein, with a deeply emarginate apex, and an extended decurrent base. Margins entire. Texture coriaceous. Length about 6.5 cm. Maximum width about 2.75 cm. Petiole short, curved, expanded proximad, about 1.5 cm. in length. Midvein stout, straight and prominent. Secondaries few, stout, immersed in the leaf substance, diverging from the midvein at wide angles, and camptodrome. Tertiaries obsolete by immersion.

This characteristic form is named for the collector. It is somewhat similar to the lower Eocene (Wilcox) *Mimusops praenuntia* Berry of this same region, but is longer, more cuneate, and more coriaceous. The two may be affiliated. It is also extremely like some of the numerous variants among the leaves of the existing *Mimusops duplicata* Urban of the Antilles, and *Mimusops balata Schomburghii* Pierre of northern coastal South America.

The genus is a moderately large one, present in all existing tropical regions and continuously represented in the geological record from the Upper Cretaceous to the present. In the Mississippi embayment region it appears to have been a prominent coastal type from the Upper Cretaceous through the

older Tertiary, where it was represented by a variety of leaves similar to those of existing tropical American species.

ERYTHRINOLEPIS (?) sp.

(Plate 11, fig. 9)

I am unable to decide conclusively whether the object figured is vegetable or a fish scale. It appears to represent the latter and to be congeneric with scales described by Cockerell[5] from the Cretaceous as species of *Erythrinolepis*.

Explanation of plates 11, 12

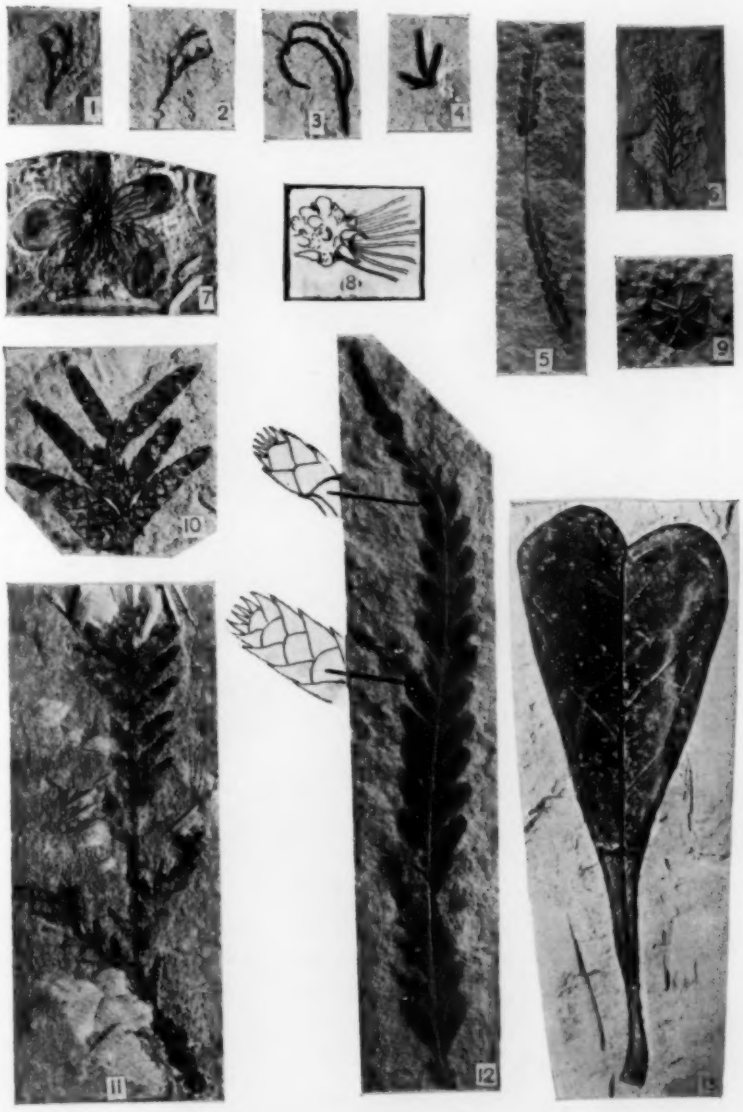
PLATE 11

Figs. 1–3. Muscites (?) Lesquereuxi Berry, n. sp.
Fig. 4. Raphaelia minuta Berry.
Fig. 5. Gleichenia delicatula Heer.
Fig. 6. Raphaelia neuropteroides Debey & Ettingshausen.
Figs. 7, 8. Antholithes ranaliformis Berry, n. sp.
Fig. 9. Fish scale of *Erythrinolepis* (?).
Figs. 10–12. Moriconia cyclotoxon Debey & Ettingshausen.
Fig. 13. Mimusops Collinsi Berry, n. sp.

PLATE 12

Potamogeton hydrocharitoides (Berry).
All from Cooper Pit, Carroll County, Tennessee. Ripley formation.

[5] Cockerell, T. D. A. U. S. Geol. Survey Prof. Paper 120: 182. *pl. 36. f. 1–6.* 1919.



BERRY: MESOZOIC FLORA

UNIV. OF MICH.

POTAMOGETON HYDROCHARITOIDES BERRY

UNIV. OF MICH.

Pollen grains in the identification and classification of plants
II. Barnadesia

R. P. WODEHOUSE

(WITH TWO TEXT FIGURES AND PLATE 13)

The forms of pollen grains are as useful as any other characters in the classification of plants; as a general rule they serve best in distinguishing and showing relationships among the higher groupings, as families, tribes, and genera, but sometimes they are also useful among species; and frequently the pollen grains reveal relationships which are obscure and difficult to demonstrate by other means. Their usefulness is limited only by the number of characters observable; in some groups of plants these are so few that little can be told of their phylogeny without aid from other characters of the plant. In other groups, however, the structure of the grain is so clearly defined and remarkably various, offering so many characters of taxonomic value, that any attempt at classification of such groups is apt to lead to error unless account is taken of the pollen-grain structure.

Such a group is the genus *Barnadesia* Mutis. The pollen grains of these plants are lophate, that is to say covered with a system of sharply elevated ridges, anastomosing and marking the surface off into variously shaped lacunae; the general plan of the pattern shows great similarity throughout the genus, but its minor deviations are sufficiently complicated to express the interrelationships between the different species and groups of species.

The pollen-grain forms of *Barnadesia* conform to the general ground plan of the Compositae in that they have three bulging germinal pores, each set in a more or less pronounced longitudinal germinal furrow or expansion fold. They are distinctive in the elaborate system of crests, anastomosing and forming patterns various in the different species. The character of these crests is distinctive for the genus; they are high and rather thin above, standing perpendicular but spreading in a gentle slope at the base to the general surface of the grain. They are smooth on top or only slightly undulating, sometimes rising a little higher

at the points of confluence and dipping slightly between, as a net stretched not too tightly between poles. The sides of these crests are likewise smooth; but they are rather transparent and when looked through, show the faintest possible vertical striae, reminiscent of the lattice structure of the corresponding crests in the pollen grains of the Vernonieae and Cichorieae.

In some species the pattern formed by the crests is exactly radiosymmetrical. For example in the pollen grains of *B. Trianae* (plate 13, fig. 1) when seen with the pole towards the observer, in the center is one large polar lacuna surrounded by six circumpolar lacunae. Three of these are opposite the pores; these are the abporal lacunae; they communicate with the poral lacunae, which enclose the pores, through broad gaps in the separating crests, thus joining the poral lacunae with their neighboring abporal lacunae in both hemispheres to form long germinal furrows. The other three circumpolar lacunae are alternate with the pores; these are the interporal lacunae; they have a tendency to become pentagonal owing to the shortening of their distal sides which abut upon the neighboring equatorial lacunae. Three equatorial lacunae are seen only from the side when the grain is observed in polar view as in figure 1. Flanking each poral lacuna are two paraporal lacunae.

Since the opposite hemisphere is exactly the same as this, it follows that the grain has in all, two polar lacunae, twelve circumpolar, twelve paraporal, three poral and three equatorial, giving a total of thrity-two lacunae. In some grains certain irregularities occur, for any one or more of the lacunae may be variously divided; but in the grains of this species such irregularities are seldom sufficient to confuse the identity of the lacunae.

In the pollen grains of *B. venosa* (fig. 2) the pattern is essentially the same as in that of *B. Trianae*, except that the poral lacunae are closed—shut off from the abporal lacunae by interlacunar crests—,though in some cases these are nearly broken through and always they are sharply bent in such a way as to permit the three lacunae to function together as a germinal furrow or expansion fold. The polar lacuna is nearly always divided by radiating crests, into three, though occasionally grains are found in which one or both of the polar lacunae are undivided or divided only into two, by a single transverse crest.

The pattern is not always as symmetrical as in the grains of *B. Trianae* and *B. venosa*. For example in the grain of *B. berberoides* (fig. 3) it is almost completely asymmetrical; only the poral and paraporal lacunae can be identified with certainty Another prominent character of this grain is the very conspicuous cap over each of the germinal pores. This cap is also found in the grains of several other species, and may be associated with both regular and irregular patterns. It is represented by only a vestige in the grains of *B. macrocephala*. Little can be said of its origin or homology, but it appears to be composed of the same material as the crests, and is strongly reminiscent of similar structures in the grains of some species of the Valerianaceae.

Making use of such features as these, it is possible to distinguish most of the species of *Barnadesia* from each other without reference to any of the characters of the plant body. The distribution of these characters among the members of the genus is expressed in the following key, which shows the differences between pollen grains of the different species, and apparently causes them to fall into a fairly natural arrangement.

Pattern radiosymmetrical or nearly so
- Caps present on germinal pores..... *B. spinosa* Linn. f. 50.0μ
  B. glomerata O. K. 45.0μ
  B. odorata Griseb. 50.0μ
- Caps absent
  - Polar lacunae generally present or variously divided; poral lacunae open..... *B. Trianae* Hieron. (Fig. 1) 50.0μ
  - Polar lacunae absent; poral lacunae closed..... *B. venosa* Rusby (Fig. 2) 67.5μ

Pattern irregular
- Aperture small..... *B. hirsuta* Sch.-Bip. 47.5μ
- Aperture large
  - Caps present..... *B. polyacantha* Wedd. 50.0μ
    B. rosea Lindl. 50.0μ
    B. berberoides Sch.-Bip. (Fig. 3) 52.0
  - Caps absent or vestigial..... *B. macrocephala* O. K. 55.0μ

This key covers all species which were available for study, except one. *Barnadesia inermis* Rusby (fig. 4) is not included in the above key. The form of its grain bears not the slightest resemblance to those of the others, except that it conforms to the general ground plan of the family in its possession of three

germinal apertures set in three longitudinal furrows. These furrows are long and deeply depressed, and the surface is faintly granular and exhibiting vestiges of spines, in these respects conforming to the general plan of pollen grain form of the tribe Mutisieae. Upon investigating the characters of the plant itself, and from reference to the author's description, I found that it did not strictly conform to the genus as described by Mutis,[1] nor even as extended by Bentham and Hooker.[2] For example it has short caudate anthers, none of the corollas in the heads are strictly bilabiate, they are slightly hairy around the margins of the teeth, and they are also somewhat hairy inside; whereas, according to the generic description of *Barnadesia* by Bentham and Hooker, the anthers are ecaudate and the corollas of at least the marginal flowers are bilabiate and densely hairy on the outside.

Upon communicating these findings to Dr. Rusby, who originally described *Barnadesia inermis*,[3] he stated that the plant had been placed in the genus with a full knowledge of the necessary extension of the generic limitations to include it, but he now believes that, in view of the pollen grain evidence and other data, it should be regarded as a species of *Chuquiraga*. This view is abundantly sustained by the evidence of its pollen grain, for it is essentially the same as that of *Chuquiraga ferox* Britton (fig. 10), *C. floribunda* (Gardn.) Baker and *C. leptacantha* (Gardn.) Baker, though somewhat different from other species of the genus.

Eliminating this species from *Barnadesia* leaves the genus compact, and obviates the necessity of extending the limits laid down by Mutis and already extended by Bentham and Hooker. To their description of the genus, however, we may add: Pollen grains 45–65 microns in diam., tricolpate, psilolophate, the spineless crests without, or with only the faintest trace of lattice structure, forming a pattern radiosymmetrical or irregular.

It is interesting to note here that another species, viz. *Barnadesia divaricata* Grisebach,[4] was formerly included in this

[1] In: Linné, C., fil. Supplementum Plantarum 55. 1781.

[2] Genera Plantarum **2**: 484. 1873.

[3] Bull. New York Bot. Gard. **4**: 399. 1907.

[4] Grisebach, A. Symb. Fl. Arg. Abhandl. Kön. Ges. Wiss. Göttingen **24**: 209. 1879.

genus. Later, however it was transferred by Baker[5] to *Chuquiraga* as *C. glabra* (Spreng.) Baker var. *varians* (Gardn.) Baker and later was given specific rank by Rusby as *Chuquiraga varians* (Gardn.) Rusby. Its pollen grains bear no resemblance to those of the true Barnadesias but are exactly like those of '*Barnadesia inermis* Rusby.'

These two species of *Chuquiraga*, which have been transferred from *Barnadesia*, together with *C. floribunda* (Gardn.) Baker, *C. leptacantha* (Gardn.) Baker, *C. vagans* Baker, and *C. ferox* Britton, are unique in the possession of three distinct concavities appearing as the impressions one could make with the thumb in a ball of soft dough. Since these impressions are between the furrows, I shall call them intercolpar concavities, and their position on the equator suggests the further designation of equatorial concavities. They have not been found elsewhere in the grains of either the Mutisieae or any other tribe of the Compositae except *Schlectendalia*. The common possession among these six species of *Chuquiraga* of intercolpar concavities, together with such various other characters as the vestigial nature of their spines, their texture, which is only faintly granular, and their spheroidal shape and similarity in size, stamps them as genetically close to each other and at the same time distinct from the other species of *Chuquiraga*, thus constituting a species group which I shall call, for the purposes of this discussion, after the last named species of the group, the **Feroces**. This group appears to correspond very closely, if indeed not exactly, to the abandoned genus *Flotovia* Spreng.

As far as I am aware no one has ever specifically questioned the position of *Barnadesia* in the Mutisieae, though several have questioned the validity and speculated on the relationships of the tribe as a whole. Thus Bentham[6] says of the Mutisieae 'They are most nearly allied in structure, though most opposed geographically, to the Cynarioideae. . . . . There are some genera also which (with *Stokesia* in the Vernonieae) exhibit the nearest approach in the order, though still but a distant one, to the Cichoriaceae.' And Small[7] says 'It is possible that Mutisieae

[5] In: Martius, C. F. P. de. Flora Brasiliensis 6[3]: 363. 1882.

[6] Bentham, G. Notes on the classification, history and geographical distribution of the Compositae. Jour. Linn. Soc. Bot. **13**: 335–577. 1873.

[7] Small, James. The origin and development of the Compositae. New Phytologist **17**: 13–40. 1928.

is not a natural group but a collection of bilabiate forms with the addition of the genera of the Gochnatiinae, which are scarcely to be distinguished from the Cynareae. That a bilabiate corolla is not a character of tribal rank is obvious from the large number of cases where it occurs in other tribes.'

Nowhere else in the Mutisieae is found any approach to the elaborate system of crests and lacunae which are characteristic of the grains of *Barnadesia*. All of the Mutisieae that have been examined, including 72 species and 31 genera, have grains with three germ pores in usually rather deeply sunken germinal furrows, and bear in their form and in the arrangement and various degrees of reduction of their spines, a truly remarkable resemblance to the grains of the Cynareae; for example the grain of *Mutisia viciaefolia* (fig. 6) is ellipsoid with three long germinal furrows, reaching almost from pole to pole; the surface is coarsely granular and beset with extremely small protuberances which are not quite regularly arranged but probably represent vestiges of spines, as I have already shown in the pollen of Euxanthium.[8] The exine is transparent and beneath it may be seen a short transverse furrow crossing the long furrow at right angles. In figure 6 this is represented by a slight shadow, though in reality it does not show in surface view. In these respects this grain is almost indistinguishable from the subechinate grained forms found among the Cynareae. Thus it appears that the affinities of most of the Mutisieae, except *Barnadesia*, are closely with the Cynareae.

The only character of apparently any consequence, used by Bentham and Hooker in placing *Barnadesia* in the Mutisieae, was its possession of bilabiate corollas in all or at least the marginal flowers. This would have to be regarded as an important character, despite the fact that it is also found in other tribes, if the bilabiate corollas in the two groups were homologous. As it is, the bilabiate corolla of *Barnadesia* (text fig. 1) has only one dorsal or inner tooth and four ventral or outer teeth, while that of the typical mutisiaceous flower (text fig. 2) has two dorsal and three ventral. This must be regarded as a very fundamental difference, and if we take into account the

[8] Wodehouse, R. P. Pollen grains in the identification and classification of plants—I. The Ambrosiaceae. Bull. Torrey Club **55**: 181–198. *f. 1+pl. 8.* **1928.**

fact that the flowers of *Barnadesia* are strictly zygomorphic, it appears that there is no way that the bilabiate *Barnadesia* corolla could have been drived from the bilabiate mutisiaceous corolla. The 1:4 arrangement of the teeth could not have arisen from the partial fusion of one of the upper teeth of the mutisiaceous corolla with one of the lower and its subsequent separation from its neighbor of the upper lip, for this must result in a lack of bilateral symmetry; nor could the *Barnadesia* corolla have arisen from a 4-toothed form split down one side and later

Fig. 1 (right). Marginal or ray flower of *Barnadesia spinosa* Mutis, showing the 1-toothed inner or upper lip and the 4-toothed outer or lower lip. This is a ray flower only in the sense that it is marginal and ligulate, but differs from all other ray flowers in that it bears a pistil and well developed stamens.

Fig. 2 (left). Marginal flower of *Mutisia campanulata* Less. This flower is pistillate only. The corolla is bilabiate but bears no real resemblance to the bilabiate corolla of *Barnadesia* because the inner or upper lip is 2-toothed and the lower or outer lip is 3-toothed.

acquiring an appendage at the base of the cleft, for the slender upper lip, though almost rudimentary, is provided with two lateral vascular bundles representing the two sides of the usual arches which are found in each of the four teeth of the lower lip. Thus we are forced to the conclusion that the upper lip represents a single tooth of a regular five-toothed corolla so oriented

that one tooth is uppermost instead of two—a rather remarkable condition in the Compositae. Consequently the very character which was used in placing *Barnadesia* among the Mutisieae would perhaps better serve for separating it from them.

The only tribes in which the pollen-grain form at all obviously approaches that of *Barnadesia* are the Cichorieae and the Vernonieae. In the Cichorieae the pollen grain is echinolophate; for example in that of *Scolymus hispanicus* (fig. 8) the surface is adorned with crests forming a pattern which is nearly always symmetrical. The crests, however, differ from those of *Barnadesia* in the possession of long sharp spines and in the conspicuous vertical striae or lattice structure, which always shows conspicuously on the walls of the crests below the spines. The pattern formed by these crests is much simpler than that of the grains of *Barnadesia*; there are only 15 lacunae as compared with the 32 or more in the grains of the different species of *Barnadesia*. The polar lacuna is absent; in its place three crests radiate from the pole. It so happens that in the grains of *Scolymus* there is no enlargment at their point of confluence at the pole, yet this is rather exceptional, for in many of the Cichorieae, this area, which I have designated as the polar area, is greatly enlarged, sometimes covering nearly half of the polar hemisphere and occupying the region of the polar lacuna of *Barnadesia*. The three abporal lacunae are well developed but the interporal lacunae have apparently fused with the adjoining paraporal lacunae. There are no equatorial lacunae, the equatorial crests reaching unbroken from pore to pore. In the grains of about 25 species of Cichorieae which have been examined only minor deviations from this type have been found. In that of only one species, viz. *Tragopogon pratensis*, was an equatorial lacuna found, and in this it is in no sense homologous with the equatorial lacuna of *Barnadesia*, for it reaches from pore to pore as if the equatorial crests were doubled, thus enclosing between them a space, which must therefore technically be called the equatorial lacuna. Altogether the pattern in the Cichorieae is much simpler and more constant in the different species than in that of *Barnadesia*. Furthermore all have crests exhibiting lattice structure and very conspicuously spined. The natural conclusion from these considerations is that the presence of crests in the grains of *Barnadesia* and the Cichorieae must be regarded

as a parallelism rather than denoting very close genetic relationship.

In the Vernonieae an enormous range of pattern is found, as if it were much less fixed than in the Cichorieae. Thus I have shown[9] that within the genus *Vernonia*, are found pollen-grain forms ranging from that of *V. stellaris* which is only slightly modified from the simple echinate form, to such complicated forms as that found in *V. Wrightii*, which is echinolophate with 30 lacunae, radiosymmetrically arranged and strikingly like those of some Barnadesias. The grains of all species of *Vernonia* have long spines; this, however, is not universal throughout the tribe, for I have shown[9] that the grains of *Pacourina edulis* show no trace of spines on the crests and those of *Stokesia* (fig. 7) only the smallest possible traces of them in some grains while others are entirely smooth. The pattern formed by the crests in the grains of *Stokesia* (fig. 7) is remarkably similar to that of *Barnadesia*. Compared with that of *B. Trianae* (fig. 1) for example, in both are six paraporal lacunae in each hemisphere; the three equatorial lacunae are large and hexagonal, and there are six circumpolar lacunae. The main difference lies in the fact that in the grain of *Barnadesia* the poral lacunae communicate through a gap in the separating crests, with the abporal lacunae in each polar hemisphere, so that the three lacunae are joined to form a long germinal furrow, while in the grain of *Stokesia* the poral lacunae are hexagonal and closed, with no provision for extending the effective length of the expansion furrow. In the grain of *Barnadesia* there is a polar lacuna, while in that of *Stokesia* it is absent. These differences are scarcely even of generic value, for I have shown (*loc. cit.*) that in *Vernonia* the presence or absence of polar lacunae affords a means of distinguishing some species groups, and the open or closed poral lacuna appears to be only of sectional value.

There is only one important detail in which the grains of *Barnadesia* differ consistently from those of the Vernonieae, and that is in the lattice structure of the crests of the latter. This consists of vertical irregularly shaped thin or perforate slits, varying somewhat in size, abundance, and form in the different species, but nevertheless universally present in the completely

[9] Wodehouse, R. P. The phylogenetic value of pollen-grain characters. Ann. Bot. **42**: [1–44.] Oct. 1928.

lophate grains of the Vernonieae, and absent or only barely suggested in the grains of all observed species of *Barnadesia*. This is the only constant distinguishing feature between the grains of the two groups. Thus it seems that *Barnadesia* is genetically close to the Vernonieae.

Why is not *Barnadesia* regarded as part of the Vernonieae? Perhaps the most important difference is found in the style, the characters of which are regarded by most synantherologists as of tribal value. In *Barnadesia* the style branches are very short, connivent or scarcely spreading, rounded on their tips and smooth, while in the Vernonieae the typical form of the style branches is slender, tapering, acute, stigmatose within and hairy without; nevertheless these characters are not constant throughout the tribe; for example in *Lychnophora uniflora* Sch. Bip., *L. rosmarinifolia* Mart., *Soaresia velutina* Sch. Bip., and *Haplostephium Passerina* Mart. the style branches are fused almost to their tips and swollen towards the apex, giving the style a clavate form not unlike that of *Barnadesia*, except that the connivent tips are pointed. In *Stilpnopappus ferrugineus* Baker the style is described as truncate.[10] In all of these the styles are hairy without, while in *Barnadesia* they are smooth, and this appears to be the only constant distinguishing character of the styles.

The heads of *Barnadesia* are generally described as radiate—and indeed they appear to be—,while the heads of the Vernonieae have no ray flowers. At first this appears to be an important distinction; however the ligulate marginal flowers of *Barnadesia* bear both stamens and pistils, whereas, in all other groups, ray flowers are always only pistillate or neutral; these marginal flowers of *Barnadesia* differ from fertile disc flowers only in the greater elongation of the lower lip. Their corollas. the limbs in particular, are distinctly hairy on the outside, a condition not common in the Vernonieae but very conspicuous in a few species, as for example, *Soaresia velutina*, in which the limb of the corolla is densely hairy.

In other characters the resemblance between the two groups is rather remarkable. Thus the involucral bracts are appressed in several spiral series in both. In *Barnadesia* they are each tipped with a minute horny point. Though in most species of the

[10] Baker, J. G., in Martius, C. F. P. de. Flora Brasiliensis 6^2: 138. 1873.

Vernonieae the involucral bracts are not spine-tipped, in several, for example *Vernonia jucunda* and *Spiracantha cornuifolia*, the spiny tips reach a high degree of development. The receptacle is flattened, rarely hairy, bristly or chaffy in the Vernonieae, while in *Barnadesia* it is flat, villous, not chaffy. In color the corolla of the Vernonieae is red, white, or blue—never yellow, while in *Barnadesia* it is generally pink, red, or purple, and never yellow. In habit the Barnadesias are shrubs or woody climbers, while the Vernonieae are herbs, shrubs, vines or small trees. The leaves in *Barnadesia* are alternate and entire, while in the Vernonieae they are alternate or scattered, and simple or serrate. The anthers in both are ecaudate, but generally more or less sagittate; this is a very important resemblance and stands in sharp contrast with the Mutisieae, in which the anthers are prevailingly long-caudate. Thus *Barnadesia* shows unmistakable affinities with the Vernonieae, possibly quite as close as to the Mutisieae.

Schlectendalia Less. is generally regarded as the closest relative to *Barnadesia*, and is included with it by Bentham and Hooker in the subtribe Barnadesieae (Gen. Plant. **2**: 215. 1873). *Schlectendalia* resembles *Barnadesia* in the possession of a corolla which is bilabiate with the 1:4 arrangement of teeth, and densely hairy on the outside. On the other hand, the corolla is also hairy on the inside, which is regarded as a character peculiar to *Chuquiraga*. Thus it appears to form in a way, a link between *Barnadesia* and *Chuquiraga*.

The pollen grain of *Schlectendalia* (fig. 9) shows unmistakable affinity with *Chuquiraga*. It possesses three long furrows and vestigial spines irregularly arranged; in these respects it is simply mutisiaceous. It also possesses three large equatorial concavities and the surface texture is only faintly granular, which may be regarded as special characters of the FEROCES, a species group of *Chuquiraga*. It is distinctive in the greater depth and more pronounced character of its three equatorial concavities and in the possession of twelve smaller depressions. These flank the pores, one below and one above the equator on each side of each of the furrows, suggesting by this arrangement the name paraporal concavities. These latter depressions, while not a prominent feature of any of the grains of *Chuquiraga*, are represented in some species of the FEROCES, e.g. *C. floribunda*

(fig. 5) by minute puckers—extremely faint but constant and unmistakably homologous with the parporal concavities of the grains of *Schlectendalia*. Thus it is seen that the difference between the grains of *Schlectendalia* and some of the FEROCES is only a matter of the size of the intercolpar concavities.

Such a form of grain as this might, with some stretch of the immagination, also be regarded as the remote beginning of that of *Barnadesia*. The fifteen concavities suggest by their position corresponding lacunae of *Barnadesia*; the large intercolpar concavities situated centrally in each lobe, would correspond to the equatorial lacunae of the grains of *Barnadesia*, and the paraporal concavities would correspond to the lacunae of the same position in the grains of *Barnadesia*. In order to derive the latter form of grain from that of *Schlectendalia* it would be necessary to enlarge and deepen the concavities, throw two walls across each furrow, making of it the poral and abporal lacunae, add two poral lacunae and three circumpolar lacunae in each hemisphere. The jump is a long one but seems possible. Such a theory has in its favor the fact that the crests of *Barnadesia* are entirely without spines, as would be expected if derived from a form that had nearly completely lost its spines,—also by the very faint suggestion of lattice structure in the crests of *Barnadesia*, as would be expected if derived from a form that had only a faintly granular texture as that of the grain of *Schlectendalia*. The granular surface, common to the grains of most of the Mutisieae and Cynareae, is seen in optical section to be caused by the rod like structure of the exine, as if made up of vertical rods packed closely together. In the Vernonieae and Cichorieae the crests exhibit a very conspicuous lattice structure, pointing to their origin from forms with coarsely granular structure, whereas in the crests of the grains of *Barnadesia* the faint suggestion of lattice structure points to their origin from a form with only a faint suggestion of granular texture. Thus it seems entirely possible that the pollen grains of *Barnadesia* could have been derived from such a form as that of *Chuquiraga ferox* through such a form as that of *Schlectendalia* by an increase in size and multiplication in number of the invaginations, a further reduction of the vestigial spines and of the faintly granular or rod like structure of the exine.

SUMMARY AND CONCLUSIONS

The pollen grains of *Barnadesia* are approximately spherical, with three germinal apertures which generally bulge prominently and are situated in more or less conspicuous germinal furrows. In these respects they conform to the general ground plan of the Compositae but they differ from it in the possession on the surface of an elaborate system of ridges and lacunae. This character, however, is shared with the two tribes Cichorieae and Vernonieae, but the grains of *Barnadesia* may be distinguished from these by the lack of lattice structure which is a prominent character of the ridges of the grains of the two latter groups, and also from the Cichorieae by the possession of two or more times as many lacunae, and the absence of spines which are characteristic of the ridges in the grains of the Cichorieae.

Included in the genus *Barnadesia* were two species, *B. inermis* Rusby and *B. divaricata* Grisebach, which have simple tricolpate pollen grains devoid of all crests and lacunae. The latter of these two has been removed from the genus by Baker, and there is ample evidence apart from the pollen-grain structure, that the former was misplaced.

The forms of the grains of *Barnadesia* bear a remarkable resemblance to those of the Vernonieae and to a certain extent to those of Cichorieae, so that there is no doubt that *Barnadesia* is closely related to the Vernonieae and somewhat less to the Cichorieae.

The pollen grains of *Schlectendalia* bear characters which denote them as unmistakably related to some species of *Chuquiraga*. They also bear on their surface pronounced depressions which correspond in arrangement to some of the lacunae of the grains of *Barnadesia*. This fact, together with the extreme reduction of the spines and the faintly granular structure of the exine of the grains of *Schlectendalia*, suggests it as a possible link between the form of the grain of *Barnadesia* and that of the FEROCES of *Chuquiraga*.

Explanation of plate 13

All figures were drawn free-hand from studies made with the aid of Karl Zeiss 4 mm., N. A. 0.95 and 2 mm., N. A. 1.3 apochromat objectives and a 10×compensating ocular. The figures are not drawn to scale; instead, each grain is drawn to a size adapted to display its characters to the best advantage. Measurements were made with an ocular micrometer used with a 2 mm. apochro-

mat objective and a 15×compensating ocular, and represent the average diameter of three or more grains in each case.

Fig. 1. Pollen grain of *Barnadesia Trianae* Hieron. 50.0μ diam. Polar view, showing the arrangement of crests and lacunae in the grains of this species in which the pattern is radiosymmetrical. In each hemisphere there is one polar lacuna surrounded by six circumpolar lacunae, three of which communicate through broad openings with the poral lacunae which are situated on the equator surrounding the pores; six paraporal lacunae, one on either side of each of the pores; three hexagonal equatorial lacunae, seen here only in side view. Since the opposite hemisphere is exactly the same, the total number of lacunae in this grain is 32.

Fig. 2. Pollen grain of *Barnadesia venosa* Rusby. 67.5μ diam. Polar view. Differs from the grain of *B. Trianae* (fig. 1) in having the polar lacuna divided into three by radiating crests and in having the germinal lacunae closed, not communicating with the abporal lacunae. Frequently in the grains of this species one or both polar lacunae may be undivided or divided only into two by a single crest.

Fig. 3. Pollen grain of *Barnadesia berberoides* Sch.-Bip. 52.0μ diam. Differs from the grain of *B. Trianae* in its irregular pattern and in its possession of caps over the germ pores. The poral and paraporal lacunae can be identified.

Fig. 4. Pollen grain of *Barnadesia inermis* Rusby. 27.5μ diam. Polar view showing its entire lack of crests and lacunae which are characteristic of the genus *Barnadesia*. This species was wrongly placed in the genus.

Fig. 5. Pollen grain of *Chuquiraga floribunda* (Gardn.) Bkr. 24.2μ diam. View slightly to one side of polar, showing intercolpar concavities; the large one in the centre of the lobe is the equatorial and the smaller near the pores are the paraporal.

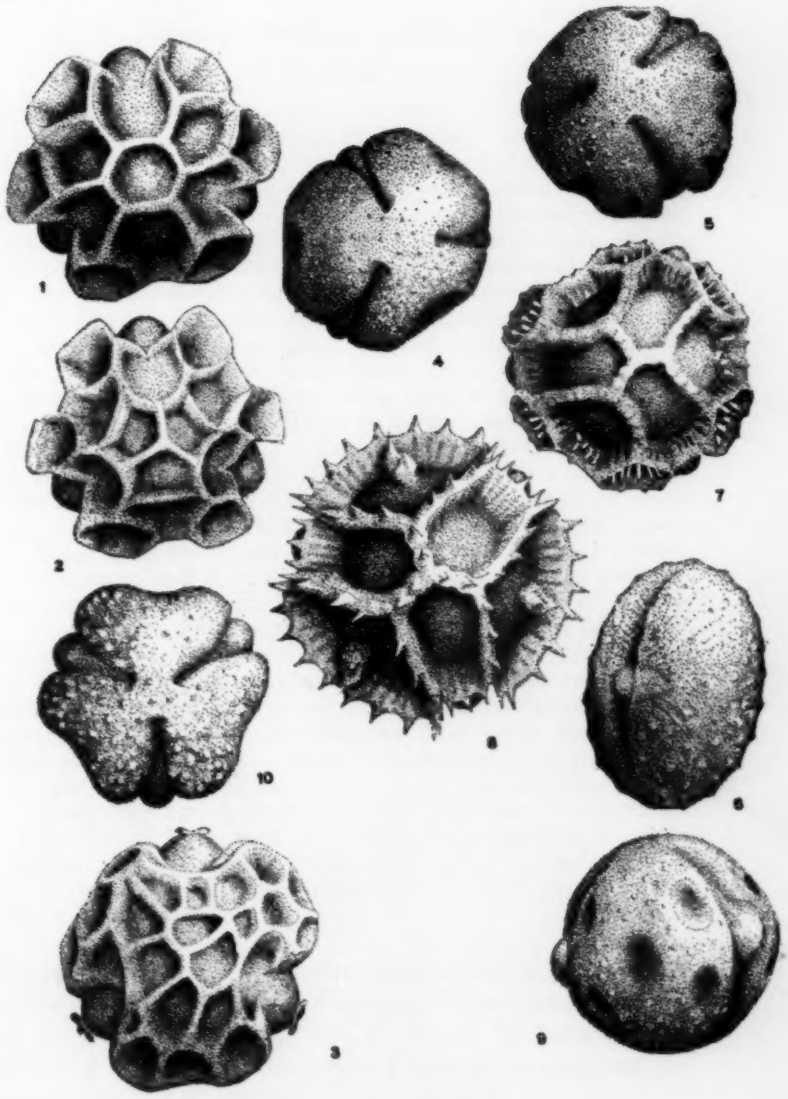
Fig. 6. Pollen grain of *Mutisia viciaefolia* Cav. 70.0×53.9μ diam. Side view showing one of its three germinal furrows and the vestiges of spines. This form represents the general ground plan of the Mutisieae or, more especially, the Mutisinae, in which subtribe *Barnadesia* is placed by Hoffman. This grain does not bear the slightest resemblance to that of *Barnadesia* but does bear a remarkable resemblance to those of some of the Cynareae.

Fig. 7. Pollen grain of *Stokesia laevis* (Hill) Greene. 55μ diam. Polar view showing the pattern characteristic of many Vernonieae and remarkably similar to that of *Barnadesia* and from which it differs in only one constant character, viz. the lattice structure of the crests, in this species perforate.

Fig. 8. Pollen grain of *Scolymus hispanicus* L. 40μ diam. Polar view, showing the pattern of fifteen lacunae, and imperforate lattice structure of the crests characteristic of the Cichorieae.

Fig. 9. Pollen grain of *Schlectendalia luzulaefolia* Less. (*Chamissomenia* O. Ktze.) 33.7μ diam. Side view showing equatorial and paraporal concavities, which may represent the remote beginnings of the lacunae of the grains of *Barnadesia*.

Fig. 10. Pollen grain of *Chuquiraga ferox* Britton. 33.0μ diam. Polar view, showing the three intercolpar concavities, vestigial spines and absence of conspicuous granular texture.



WODEHOUSE: POLLEN GRAINS

UNIV. OF MICH.

Notes on southeastern woody plants

W. W. Ashe

Viburnum ozarkense sp. nov. A shrub 1 to 2.6 m. high with wand-like or dichotomously forking stems, usually several together. Pith white, solid, occupying about one third of the diameter of the winter twig of the year, which is obtusely angled, glabrous, gray-brown, becoming gray the second year and marked by few small lenticels. Winter buds short, broadly conical, 3 to 4 mm. long, of about 4 pairs of opposite scales, the outer short and glabrous, the inner pubescent, ciliate, more or less granular-glandular and accrescent in aestivation, becoming 2 to 3 cm. long. Inflorescence a 5 to 7-rayed compound cyme, 4 to 6 cm. wide, from 2.5 to 3 cm. high, and subtended by linear-lanceolate ciliate bracts, 1 to 2 cm. long and often equalling in length the rays and partly persistent, raylets with bracts .8 to 1.3 cm. long, erect or ascending, largely persistent and much overtopping the flowers, which are white, about 8 mm. across, the hairy corolla having deep rounded lobes; calyx teeth short and ciliate; stamens about 15 mm. long, anthers yellow. Leaves ovate or broadly ovate, 8 to 11 cm. long and 6 to 9.5 cm. wide with a broad shallow sinus at base and abruptly taper-pointed at the apex, usually 5 to 7 pairs of prominent veins, those above the much branched basal pair rarely branching more than twice, with distant but shallow sinuate teeth, soon glabrous above, ciliate on margin and pubescent over entire lower surface, but more so on the veins, with short simple hairs; petioles 2 to 4 cm. long, channeled but at length seeming terete from incurving of the edges, granular-glandular and ciliate, with 1 or 2 pairs of linear ciliate deciduous stipules about 1 cm. long near the base. Fruit blue-black, 8 to 11 mm. long; seed about two thirds the length of the fruit, flattened on one face and with two shallow lateral grooves, convex on the other with two deep lateral grooves separated by a prominent ridge.

Viburnum ozarkense is frequent along streams, particularly on sandy soils in Stone county, Arkansas. Type from Sylamore, May 8, 1924 and August 28, 1926, W. W. A. It flowers about the middle of May, when the leaves are nearly grown, and the fruit ripens the last of August.

The proposed species apparently has been confused with *V. molle* Michx. of Missouri, Kentucky and Illinois, from which it is separated by having prevailingly oval or broadly ovate

leaves of relatively longer and narrower outline, those of *V. molle* being nearly orbicular in outline and abruptly acuminate; by its coarser venation, 5 to 7 pairs of prominent veins, *V. molle* prevailingly having from 8 to 10; by its coarser serration, shorter petioles, longer peduncles, glandular pubescence and bracted cymes.

From *Viburnum bracteatum* Rehd. of Alabama and Georgia, to which it is more closely related, it is separated by its relatively narrower and less deeply cordate leaves, prevailingly more acuminately toothed and more pubescent on the lower surface, by the much longer petioles and by the cymes being bracted as well as the raylets, the bracts of which characterize *V. bracteatum*.

CRATAEGUS AESTIVALIS var. **Dormonae** var. nov. Leaves as in the type form but thicker and dentate, appressed pubescent above as they unfold with the flowers early in March, eventually glabrate above except for the midrib, below permanently pale gray pubescent along the midrib and with prominent tufts in the axils of the veins; petiole permanently pubescent. Flowers 17 to 20 mm. wide, anthers deep rose; calyx lobes entire, short-triangular, glabrous, either spreading or with ascending tips from a keeled base and coloring with the fruit. Fruit, ripening and falling the last of June with the pedicels attached, bright glossy red, usually slightly depressed, rarely oblong, from 10 to 14 mm. long; flesh pale yellow, soft and pleasantly acid when mature.

Miss Caroline Dormon, Black Lake, Natchitoches Parish, La., March and June 1927; March 9 and June 24, 1928 (type, herbarium of W. W. A.). Known as June haw.

TULIPASTRUM ACUMINATUM var. **ludovicianum** n. comb. —*Magnolia acuminata* var. *ludoviciana* Sarg. (Bot. Gaz. **67:** 232. 1919). Differing from the type in its broader leaves and larger flowers; but like the type in its leaves being pubescent and glaucescent beneath.

TULIPASTRUM ACUMINATUM var. **ozarkense** n. comb.—*Magnolia acuminata* var. *ozarkensis* Ashe (Jour. Elisha Mitchell Soc. **41:** 269. 1926). Differing from the type in its very broad leaves soon glabrous and bright green on both surfaces.

MAGNOLIA VIRGINIANA var. **parva** var. nov. Differing from the type in its smaller flowers, the petals seldom as much as 2.5 cm. long and 1.5 cm. wide; leaves 6 to 12 cm. long by 2 to 4.5 cm. wide. Type W. W. A. near Sopchoppy, Wakulla Co., Fla., May 17, 1925.

Quercus **pygmea** (Sargent) sp. nov.—*Q. virginiana* var. *pygmea* Sarg., (Bot. Gaz. **65**: 449. 1918). A shrub 6 to 12 dm. tall with shoot of the season at first pubescent, at length glabrate. Leaves 3 to 6 cm. long by 2 to 2.7 cm. wide, prevailingly broadest above the middle, narrowed to the cuneate base, or those toward the ends of the shoots elliptic or oblong and often with acute shallow lobes above the middle, dark green and glabrous above, sparingly pubescent on the lower surface, sometimes with revolute margins. Fruit, 1 to 1.6 cm. long, the cups with acute bases from 1.1 to 1.5 cm. in diameter, and nearly enclosing the oblong nut, usually solitary and sessile or on a short peduncle.

This plant is not only quite distinct from *Q. minima* Small (*Q. virginiana* var. *dentata* Chapm.) but the smaller nut nearly enclosed in the cup, which is sessile or nearly so, are constant characters not found in the other live oaks, uniformly serving to separate it from all related forms.

TILIA CRENO-SERRATA var. **acuminata** var. nov. This differs from the type in the acuminately pointed leaves and like the type it often has summer shoots which are velvety pubescent. Type: Prof. M. D. Cody and W. W. A. near Gainesville, Fla., June 9, 1925.

HICORIA LEIODERMIS var. **mollissima** n. comb.—*H. mollissima* Ashe (Jour. Elisha Mitchell Soc. **39**: 46. 1924). Both *Hicoria leiodermis* and its variety *callicoma* are described (as *Carya*) by Dr. Sargent (Bot. Gaz. **66**: 239 seq. 1918) as having the mature foliage slightly pubescent on the lower surface. In the variety *mollissima* the leaflets on lower surface and petioles are permanently soft velvety pubescent.

RHUS **illinoiensis** n. comb.—*Schmaltzia illinoinesis* Greene (Leaf. **1**: 131. 1905). At the same time that Greene described this species he described, and in the order given, *S. formosa* and *S. serotina*. So far as can be determined all of these seem to represent the same species, and by combining their descriptions, a very good characterization is secured of the plant. It seems to be a well marked species amply separated from the two others with which often associated by its larger size, 1 to 1.3 m. high, stout twigs, larger leaves and later time of flowering, which is when the leaves are about half grown. The staminate plants with their large clusters of bright yellow flowers are particularly striking in mid spring, blooming a full month after *R. trilo-*

bata Nutt. and *R. aromatica* Ait. The terminal leaflet is either pointed or rounded at the apex, but is prevailingly rhombic in outline.

It is essentially Ozarkian in its distribution. *R. illinoiensis* is described as having pubescent twigs and leaves. It passes into *R. illinoiensis* var. **formosa** n. var. (*S. formosa* Greene *loc. cit.*) which is glabrate.

WASHINGTON, D. C.

INDEX TO AMERICAN BOTANICAL LITERATURE
1927–1928

This index is reprinted monthly on cards, and furnished in this form to subscribers at the rate of three cents for each card. Selections of cards are not permitted; each subscriber must take all cards published during the term of his subscription. Correspondence relating to the Index may be addressed to the Treasurer of the Torrey Club.

Abbot, C. G. Influences of sun rays on plants and animals. Smithsonian Rep. **1926**: 161–173. *pl. 1–5.* 1927.

Alexander, E. J. *Azalea calendulacea*. Addisonia **13**: 17–18. *pl. 425.* 11 Jl 1928.

Alexander, E. J. *Helonias bullata*. Addisonia **13**: 23–24. *pl. 428.* 11 Jl 1928.

Allyn, W. P. The relation of lime to the absorption of iron by plants. Proc. Indiana Acad. Sci. **37**: 405–409. 1923.

Andrews, F. M. Deposition of material by water plants. Proc. Indiana Acad. Sci. **37**: 327–329. 1928.

Andrews, F. M. Modified *Narcissus* flowers. Proc. Indiana Acad. Sci. **37**: 326–327. 1928.

Andrews, F. M. Monstrosities in *Trillium*. Proc. Indiana Acad. Sci. **37**: 325–326. 1928.

Andrews, F. M. Some flowering plants of Monroe County, Indiana. Proc. Indiana Acad. Sci. **37**: 330–334. 1928.

Andrews, F. M. A study of lichens. Proc. Indiana Acad. Sci. **37**: 329–330. 1928.

Angst, L. Gametophytes of *Costaria costata*. Puget Sound Biol. Sta. Publ. **5**: 293–307. *pl. 18–21.* 20 D 1927.

Angst, L. The holdfast of *Soranthera ulvoidea*. Puget Sound Biol. Sta. Publ. **5**: 267–275. *pl. 16, 17.* 20 D 1927.

Angst, E. C. Observations on *Pteris aquilina*. Puget Sound Biol. Sta. Publ. **5**: 261–265. *pl. 15.* 20 D 1927.

Arnold, R. E. Some *Stanhopea* species. Orchid Rev. **36**: 138–142. 1 My 1928.

Asplund, E. Eine neue Balanophoraceen-Gattung aus Bolivien. Svensk. Bot. Tidsk. **22**: 261–277. *f. 1–3.* 1928.

Austin, L. Breeding pines for more rapid growth. Jour. Heredity **19**: 289–301. *f. 1–6+ frontispiece.* Jl 1928.

Bade, E. The cell as a unit of the plant. Gard. Chron. Am. **32**: 224, 228. Au 1928.

Bade, E. Pollen and artificial fertilization of plants. Gard. Chron. Am. **32**: 7–8. *f. 1–5.* Ja 1928.

Baldwin, H. I. A comparison of the available moisture in sod and open soil by the soil-point method. Bull. Torrey Club **55**: 251–255. "My" 12 Jl 1928.

Behrens, O. The ferns of Turkey Run. Proc. Indiana Acad. Sci. **37**: 377–379. 1928.

Berry, E. W. The flora of the Esmeralda Formation in western Nevada Proc. U. S. Nat. Mus. **72**[23]: 1–15. *pl. 1, 2.* 1927.

Bessey, E. A. Effect of the age of pollen upon the sex of hemp. Am. Jour. Bot. **15**: 405–411. Jl 1928.

Blakeslee, A. F. Genetics of *Datura*. Verh. V. Internat. Kongr. Vererb. **1**: (Zeits. Indukt. Abst. suppl. 1:) 117–130. *f. 1–3.* 1928.

Blakeslee, A. F., & Cartledge, J. L. Sterility of pollen in *Datura*. Mem. Hort. Soc. N. Y. **3**: 305–312. *pl. 24+f. 1.* Jl 1927.

Bodenberg, E. T. Experiments on conduction in *Nereocystis Luetkeana*. Puget Sound Biol. Sta. Publ. **5**: 253–256. 20 D 1927.

Bodenberg, E. T. Tissues involved in the transfer of mineral salts in plants. Puget Sound Biol. Sta. Publ. **5**: 231–244. 20 D 1927.

Bottomley, M. E. How the ancient water lily became modern. Parks & Recreation **11**: 404–409. *illust.* Au 1928.

Boyce, J. S. A possible alternate stage of *Pucciniastrum Myrtilli* (Schum.) Arth. Phytopathology **18**: 623–625. Jl 1928.

Boynton, K. R. *Gongea tomentosa*. Addisonia **13**: 19–20. *pl. 426.* 11 Jl 1928.

Boynton, K. R. *Salix caprea elliptica*. Addisonia **13**: 27–28. *pl. 430.* 11 Jl 1928.

Buchholz, J. T., & Blakeslee, A. F. Pollen-tube behavior with reference to sterility in *Datura*. Mem. Hort. Soc. N. Y. **3**: 245–260. *pl. 16–18+f. 1–5.* Jl 1927.

Burge, W. E., & Burge, E. L. A study of the effect of hot and cold weather on the catalase of the plant and animal in relation to their respiratory metabolism. Am. Jour. Bot. **15**: 412–415. *f. 1.* Jl 1928.

Bush, B. F. *Quercus neo-Ashei*. Bull. Torrey Club **55**: 247–250. "My" 12 Jl 1928.

Byhouwer, J. T. P. Notes on Chinese *Berberis*. Jour. Arnold Arbor. **9**: 131–137. Jl 1928.

Campbell, D. H. The embryo of *Equisetum debile*, Roxb. Ann. Bot. **42**: 717–728. *pl. 13+f. 1–10.* Jl 1928.

Chaney, R. W. Geology and palaeontology of the Crooked River basin, with special reference to the Bridge Creek flora. Carnegie Inst. Publ. 346: 45–138. *pl. 1–20+f. 1–4.* 1927.

Chaney, R. W. Hackberry seeds from the Pleistocene Loess of northern China. Am. Mus. Nov. 283: 1–2. 13 S 1927.

Chun, W. Y. Four new ligneous plants from Kwangtung. Jour. Arnold Arbor. **9**: 126–130. Jl 1928.

Clausen, R. E. Interspecific hybridization and the origin of species in *Nicotiana*. Verh. V. Internat. Kongr. Vererb. **1**: (Zeits. Indukt. Abs. suppl. **1**:) 547–553. *f. 1.* 1928.

Clausen, R. E. Interspecific hybridization in *Nicotiana*. VII. The cytology of hybrids of the synthetic species, *digluta*, with its parents, *glutinosa* and *Tabacum*. Univ. Calif. Publ. Bot. **11**: 177–211. *f. 1–43.* 26 My 1928.

Cleland, R. E. The genetics of *Oenothera* in relation to chromosome behavior, with special reference to certain hybrids. Verh. V. Internat. Kongr. Vererb. **1**: (Zeits. Indukt. Abst. suppl. **1**:) 554–567. 1928.

Clements, F. E. Ecology. Carnegie Inst. Year Book **26**: 305–340. 1927.

Coker, W. C. The Chapel Hill species of the genus *Psalliota*. Jour. Elisha Mitchell Sci. Soc. **43**: 243–256. *pl. 38–46, 48.* Jl 1928.

Coker, W. C. The distribution of the Venus's fly trap (*Dionaea muscipula*). Jour. Elisha Mitchell Sci. Soc. **43**: 221–228. *pl. 33.* Jl 1928.

Coker, W. C. Notes on Basidiomycetes. Jour. Elisha Mitchell Sci. Soc. **43**: 233–242. *pl. 36, 37, 47, 48,+frontispiece.* Jl. 1928.

New species are described in *Saccoblastia* (1), *Exidia* (1), and *Eichleriella* (1).

Colby, A. S. The inheritance of anthracnose resistance in certain raspberry hybrids. Jour. Heredity **19**: 377–382. *f. 17, 18.* Au 1928.

Cook, M. T., & Gleason, H. A. Ecological survey of the flora of Porto Rico. Jour. Dep. Agr. Porto Rico **12**: 1–139. *f. 1–75.* Jl 1928.

Cooper, W. C., & Blinks, L. R. The cell sap of *Valonia* and *Halicystis*. Science II. **68**: 164–165. *f. 1.* 17 Au 1928.

Crist, J. W., & Dye, M. Greenness and vitamin A in plant tissue. Sci. Mo. **27**: 166–171. Au 1928.

Cunningham, H. S. Histology of the lesions produced by *Sphaceloma Fawcettii* Jenkins on leaves of *Citrus*. Phytopathology **18**: 539–545. *f. 1, 2.* Je 1928.

Davies, P. A. The effect of high pressure on the percentages of soft and hard seeds of *Medicago sativa* and *Melilotus alba*. Am. Jour. Bot. **15**: 433–436. Jl 1928.

Davis, W. H. A powdery mildew parasitizing Chinese cabbage. Phytopathology **18**: 611–615. *pl. 13+f. 1.* Jl 1928.

Dawson, M. L., & Povah, A. H. A new *Rhizopus* rot of rutabaga. Science II. **68**: 112. 3 Au 1928.

Deam, C. C. Plants new or rare in Indiana. XIV. Proc. Indiana Acad. Sci. **37**: 321–323. 1928.

Dixon, H. N. *Homaliopsis* Dix. and P. de la Varde, gen. nov. Muscorum. Ann. Bryol. **1**: 47–48. 1928.

Doak, K. D. Mycorrhiza bearing species in the vicinity of Lafayette, Indiana. Proc. Indiana Acad. Sci. **37**: 427–439. *f. 1–5.* 1928.

Drayton, F. L. Common bulb diseases. Canada Dep. Agr. Bull. 95: 41–53. *pl. 13–18.* 1928.

Du Rietz, G. E. *Gyrophora rigida* DR. in North America. A new member of the west-arctic element in the Scandinavian mountain-flora. Svensk Bot. Tidsk. **22**: 278–281. 16 Je 1928.

East, E. M. Heredity in the genus *Fragaria* with special reference to the false hybrids of Millardet. Verh. V. Internat. Kongr. Vererb. **1**: (Zeits. Indukt. Abst. suppl. **1**:) 625–630. 1928.

East, E. M. The genetics of trimorphism in *Lythrum Salicaria*. Verh. V. Internat. Kongr. Vererb. **1**: (Zeits. Indukt. Abst. suppl. **1**:) 618–624. 1928.

Edmondson, T. W. *Solidago calcicola* in Matane Co., Quebec. Rhodora **30**: 157. Au 1928.

Eisenmenger, W. S. Toxicity, additive effects, and antagonism of salt solutions as indicated by growth of wheat roots. Bull. Torrey Club **55**: 261–304. "Je" 2 Au 1928.

Erlanson, E. W. Ten new American species and varieties of *Rosa*. Rhodora **30**: 109–121. "Je" 17 Jl 1928.

Essig, E. O. Charles Fuller Baker. Philip. Jour. Sci. **35**: 429–437. *pl. 1*. Ap 1928.

Everett, T. H. Curious insectivorous plants. Gard. Chron. Am. **32**: 14, 18. Ja 1928.

Eyster, W. H. The mechanism of variegations. Verh. V. Internat. Kongr. Vererb. **1**: (Zeits. Indukt. Abst. suppl. **1**:) 666–686. 1928.

Fant, G. W. The development of peach sooty mold at normal and low temperatures. Jour. Elisha Mitchell Sci. Soc. **43**: 217–220. *pl. 31, 32*. Jl 1928.

Fernald, M. L. *Eragrostis peregrina* versus *E. Damiensiana*. Rhodora **30**: 155–157. Au 1928.

Fernald, M. L. *Roripa islandica* and *R. hispida*. Rhodora **30**: 131–133. 24 Jl 1928.

Fernald, M. L. Unverified geographical ranges. Science II. **68**: 145–149. 17 Au 1928.

Fernald, M. L., & Kelsey, S. L. A new *Oxytropis* from the Gaspé Coast. Rhodora **30**: 121–124. "Je" 17 Jl 1928.

Gadsby, J. H. Plant introduction at Miami. Parks & Recreation **11**: 409–410. Au 1928.

Gaines, E. F. New physiologic forms of *Tilletia levis* and *T. Tritici*. Phytopayhology **18**: 579–588. Jl 1928.

Gardner, M. W. Apple diseases, 1927. Trans. Indiana Hort. Soc. **1927**: 27–30. 1928.

Gardner, M. W. Indiana plant diseases, 1926. Proc. Indiana Acad. Sci. **37**: 411–426. *f. 1–9*. 1928.

Gardner, M. W., & Kendrick, J. B. Potato mosaic and leaf roll: spread and effect on yield. Trans. Indiana Hort. Soc. **1927**: 158–168. 1928.

Gardner, N. L. New Myxophyceae from Porto Rico. Mem. N. Y. Bot. Gard. **7**: 1–144. *pl. 1–23*. 1 Mr 1927.

Gerdel, R. W. The colorimetric determination of total phosphorous in plant solutions. Ohio Jour. Sci. **28**: 229–235. Jl 1928.

Gregory, C. T. Controlling tomato leaf mold in green-houses in Indiana. Proc. Indiana Acad. Sci. **37**: 382–385. *f. 1, 2*. 1928.

Gregory, C. T., & Davis, J. J. Common garden pests. What they are and how to control them. 1–150. *illust.* Des Moines, 1928.

Hansen, A. H. Recent Indiana weeds, 1927. Proc. Indiana Acad. Sci. **37**: 319–320. 1928.

Hansen, N. E. The relative value of homozygous and heterozygous parents in the breeding of the apple, plum, cherry, grape, and other fruits. Verh. V. Internat. Kongr. Vererb. **2**: (Zeits. Indukt. Abst. suppl. **2**:) 796–812. 1928.

Haupt, A. W. Fundamentals of biology. i–xii, 1–358. *f. 1–256.* New York, 1928.

Haymaker, H. H. Pathogenicity of two strains of the tomato-wilt fungus, *Fusarium Lycopersici* Sacc. Jour. Agr. Res. **36**: 675–719. *f. 1–8.* "15 Ap" Jl 1928.

Haymaker, H. H. Relation of toxic excretory products from two strains of *Fusarium Lycopersici* Sacc. to tomato wilt. Jour. Agr. Res. **36**: 697–719. *f. 1–5.* "15 Ap" Jl 1928.

Herzog, T. *Scapania portoricensis* Hpe. et G. Ann. Bryol. **1**: 91–112. *f. 1–10.* 1928.

Hicken, C. M. La flore de la période crétacée et ses relations avec la flore actuelle. An. Soc. Sci. Argentine **105**: 272–277. Je 1928.

Hill, J. B. The migration of *Bacterium tumefaciens* in the tissue of tomato plants. Phytopathology **18**: 553–564. *pl. 12+f. 1.* Jl 1928.

Hollick, A. A white oak killed by lightning. Jour. N. Y. Bot. Gard. **29**: 179–182. *f. 7.* Jl 1928.

Holroyd, R. Medulary bundles in *Lobelia puberula.* Am. Jour. Bot. **15**: 442–447. *f. 1.* Jl 1928.

Hoskins, J. H. Structure of some carboniferous plants from Illinois. Proc. Indiana Acad. Sci. **37**: 373–376. 1928.

House, H. D., & Alexander, W. P. Flora of the Allegany State Park region. N. Y. St. Mus. Handbook 2: 1–225. 1927.

Howe, M. A. Notes on some marine algae from Brazil and Barbados. Jour. Wash. Acad. Sci. **18**: 186–194. *f. 1, 2.* 4 Ap 1928.

Includes *Porphyra Roseana* and *Cottoniella sanguinea*, spp. nov.

Hu, H. H. *Sinojackia*, a new genus of Styracaceae from southeastern China. Jour. Arnold Arbor. **9**: 130–131. Jl 1928.

Hursh, C. R. The reactions of plant stems to fungous products. Phytopathology **18:** 603–610. *f. 1.* Jl 1928.

Illick, J. S. Common trees of New York. 1–121. *illust.* Washington, D. C., 1927.

Immer, F. R., & Christensen, J. J. Determination of losses due to smut infections in selfed lines of corn. Phytopathology **18:** 599–602. Jl 1928.

Immer, F. R., & Christensen, J. J. Influence of environmental factors on the seasonal prevalence of corn smut. Phytopathology **18:** 589–598. *f. 1.* Jl 1928.

Jackson, J. R., & Rickett, H. W. Staining reactions of fern gametes. Science II. **68:** 89–90. 27 Jl 1928.

Jones, D. F. Burbank's results with plums. Jour. Heredity **19:** 358–371. *f. 8–14.* Au 1928.

Kidder, N. T. *Chenopodium carinatum* and other unusual weeds. Rhodora **30:** 158. Au 1928.

Kidder, N. T. *Lemna trisulca* at Isle au Haut, Maine. Rhodora **30:** 121. "Je" 17 Jl 1928.

Kisser, J., & Anderson, D. B. A method of preparing thin cross and longitudinal sections of cotton fibres, and its importance in cell-wall research. Am. Jour. Bot. **15:** 437–441. *f. 1.* Jl 1928.

Kobuski, C. E. A monograph of the American species of the genus *Dyschoriste.* Ann. Missouri Bot. Gard. **15:** 9–90. *pl. 3–16+f. 1–3.* 30 Ap 1928.

Twelve new species are described.

Kobuski, C. E. A new genus of the Acanthaceae. Ann. Missouri Bot. Gard. **15:** 1–8. *pl. 1, 2.* 30 Ap 1928.

Lehman, S. G. Frog-eye leaf spot of soy bean caused by *Cercospora diazu* Miura. Jour. Agr. Res. **36:** 811–833. *f. 1–10.* "1 My" Au 1928.

Lepeschkin, W. W. The chemical and physical composition of protoplasm. Science II. **68:** 45–48. 20 Jl 1928.

Lepeschkin, W. W. The effect of ethyl alcohol on the turgor-pressure of *Spirogyra.* Am. Jour. Bot. **15:** 422–424. Jl 1928.

Lesley, J. W., & Lesley, M. M. The "wiry" tomato. Jour. Heredity **19:** 337–344. *f. 1–6+frontispiece.* Au 1928.

Linder, D. H. Concerning the status of the genus *Laternea.* Ann. Missouri Bot. Gard. **15:** 109–112. *pl. 20.* 30 Ap 1928.

Lindstrom, E. W. Linkage of size, shape and color genes in *Lycopersicum*. Verh. V. Internat. Kongr. Vererb. **2**: (Zeits. Indukt. Abst. suppl. **2**:) 1031–1057. *f. 1–5*. 1928.

Littlefield, E. W. An uncommon association of pines in northern New York. Rhodora **30**: 129–131. 24 Jl 1928.

Lynn, M. W., Jr. The bog-clearweed, *Adicea fontana* Lunell in Indiana. Proc. Indiana Acad. Sci. **37**: 403–404. *f. 1*. 1928.

MacArthur, J. W. A spontaneous tomato chimera. Jour. Heredity **19**: 331–334. *f. 13–15*. Jl 1928.

MacDougal, D. T., & Long, F. L. Characters of cells attaining great age. Am. Nat. **61**: 385–406. *f. 1–4*. O 1927.

Mackie, W. W. A field method of insuring positive attack with some cereal diseases. Phytopathology **18**: 617–621. Jl 1928.

McLean, F. T. The sportsman's chance in *Gladiolus*. Gard. & Home Build. **47**: 547–548, 572. *illust*. Au 1928.

Macoun, W. T. McIntosh apple a parent in breeding new varieties. Verh. V. Internat. Kongr. Vererb. **2**: (Zeits. Indukt. Abst. suppl. **2**:) 1087–1089. 1928.

Mains, E. B. Observations concerning clover diseases. Proc. Indiana Acad. Sci. **37**: 355–364. *f. 1–6*. 1928.

Mains, E. B. Plant diseases in a home garden. Proc. Indiana Acad. Sci. **37**: 341–353. *f. 1–10*. 1928.

Malme, G. O. A. N. *Buelliae* itineris Regnelliani primi. Ark. Bot. **21**: 1–42. 1928.

Mason, T. G., & Maskell, E. J. Studies on the transport of carbohydrates in the cotton plant. II. The factors determining the rate and the direction of movement of sugars. Ann. Bot. **42**: 571–636. *f. 1–14*. Jl 1928.

Massey, L. M. Dry rot on *Gladiolus* corms. Phytopathology **18**: 519–529. *pl. 10, 11+f. 1–3*. Je 1928.

Mathias, M. E. Studies in the Umbelliferae. I. Ann. Missouri Bot. Gard. **15**: 91–108. *pl. 17–19+f. 1*. 30 Ap 1928.

Matthews, V. D. *Nowakowskiella* and a new species of *Pythium*. Jour. Elisha Mitchell Sci. Soc. **43**: 229–232. *pl. 34, 35*. Jl 1928.

Monteith, J. Jr., & Dahl, A. S. A comparison of some strains of *Rhizoctonia Solani* in culture. Jour. Agr. Res. **36**: 897–903. *f. 1–4*. "15 My" Au 1928.

Newton, G. A. Some fungi of the *Stemphylium* type and their relation to apple rots. Phytopathology **18**: 565–578. *f. 1–7*. Jl 1928.

Ogilvie, L. "Black tip" a finger-tip disease of the Chinese banana in Bermuda. Phytopathology **18**: 531–538. *f. 1–3.* Je 1928.

Osvald, H. Nordamerikanska mosstyper. Svensk. Bot. Tidsk. **22**: 377–391. *f. 1–12.* 16 Je 1928.

Otis, C. H. The viability of algae. Science II. **68**: 134–135. 10 Au 1928.

Owen, F. V. Soybean seeds with two embryos. Jour. Heredity **19**: 373–374. *f. 16.* Au 1928.

Pennell, F. W. *Mazus japonicus.* Addisonia **13**: 25, 26. *pl. 429.* 11 Jl 1928.

Pennell, F. W. Notes on Scrophulariaceae of the northwestern United States. Bull. Torrey Club **55**: 315–318. "Je" 2 Au 1928.

Scrophularia oregana and *Pedicularis rainierensis* are described as new species.

Percival, J. Hybrids of *Aegilops* sp.×wheats. Verh. V. Internat. Kongr. Vererb. **2**: (Zeits. Indukt. Abst. suppl. **2**:) 1182–1183. 1928.

Pilger, R. Die Gattung *Plantago* in Zentral- und Südamerika. Bot. Jahrb. **62**: 1–112. *pl. 1–7.* 1 Jl 1928.

Porter, C. L. Ecological relationships of fungi in cultures. Proc. Indiana Acad. Sci. **37**: 391–393. 1928.

Rea, H. E. Asexual reproduction of cotton. Jour. Heredity **19**: 357. *f. 7.* Au 1928.

Reddick, D. Blight-resistant potatoes. Phytopathology **18**: 483–502. Je 1928.

Reddy, C. S., & Holbert, J. R. Differences in resistance to bacterial wilt in inbred strains and crosses of Dent corn. Jour. Agr. Res. **36**: 905–910. *f. 1, 2.* "15 My" Au 1928.

Reed, F. D. Holdfast cells in *Spirogyra.* Proc. Indiana Acad. Sci. **37**: 339–340. *f. 1.* 1928.

Rehder, A., & Wilson, E. H. Enumeration of the ligneous plants collected by J. F. Rock on the Arnold Arboretum Expedition to northwestern China and northeastern Tibet. Jour. Arnold Arbor. **9**: 37–125. *pl. 12.* Jl 1928.

Rosendahl, C. O. Evidence of the hybrid nature of *Betula Sandbergi.* Rhodora **30**: 125–129. *pl. 170+f. 1.* 24 Jl 1928.

Rydberg, P. A. Genera of North American Fabaceae IV. Tribe Psoraleae (continued). Am. Jour. Bot. **15**: 425–432. *pl. 26–28.* Jl 1928.

Rydberg, P. A. *Sedum ternatum.* Addisonia **13**: 21–22. *pl. 427.* 11 Jl 1928.

Sax, K. Chromosome behavior in *Triticum* hybrids. Verh. V. Internat. Kongr. Vererb. **2**: (Zeits. Indukt. Abst. suppl. **2**:) 1267–1284. *f. 1–14.* 1928.

Schaffner, J. H. Additions to the catalog of Ohio vascular plants for 1927. Ohio Jour. Sci. **28**: 205–214. Jl 1928.

Schertz, F. M. Our search for chlorophyll and for the vitamins. Science II. **68**: 48–53. 20 Jl 1928.

Schulz, P. Beiträge zur Kenntnis fossiler und rezenter Silicoflagellaten. Bot. Archiv. **21**: 225–292. *f. 1–83.* Je 1928.

Setchell, W. A. Coral reefs as zonational plant formations. Science II. **68**: 119–121. 10 Au 1928.

Shull, G. H. A new gene mutation (Mut. bullata) in *Oenothera Lamarckiana* and its linkage relations. Verh. V. Internat. Kongr. Vererb. **2**: (Zeits. Indukt. Abst. suppl. **2**:) 1322–1343. *f. 1–8.* 1928.

Smith, C. O. Oleander bacteriosis in California. Phytopathology **18**: 503–518. *pl. 7–9.* Je 1928.

Sprague, T. A. The orchid-flowered butterworts. Kew Bull. Misc. Inf. **1928**: 230–234. 1928.

Stewart, G. Correlated inheritance in Kanred×Sevier varieties of wheat. Jour. Agr. Res. **36**: 873–896. "15 My" Au 1928.

St. John, H. The desert pansy. Am. Bot. **34**: 89–94. *illust.* Jl 1928.

Stout, A. B. A new hardy seedless grape. Jour. Heredity **19**: 317–323. *f. 7–10.* Jl 1928.

Stout, A. B. Studies of the inheritance of self- and cross-incompatibility. Mem. Hort. Soc. N. Y. **3**: 345–352. *pl. 28, 29.* Jl 1927.

Stout, A. B. Types of sterility in plants and their significance in horticulture. Mem. Hort. Soc. N. Y. **3**: 3–8. Jl 1927.

Straight, E. M. Some flowering bulbs. Canada Dep. Agr. Bull. 95: 1–41. *pl. 1–12.* 1928.

Svenson, H. K. Additions to the flora of Cape Cod. Rhodora **30**: 135–136. 24 Jl 1928.

Swallen, J. R. The grass genus *Schizachne.* Jour. Wash. Acad. Sci. **18**: 203–206. 19 Ap 1928.

Tanaka, T. Two new genera and new combinations of Rutaceae –Aurantieae from Papua. (Revisio Aurantiacearum II). Jour. Arnold Arbor. **9**: 137–141. Jl 1928.

Taylor, W. P., & McGinnies, W. G. The bio-ecology of forest and range. Sci. Monthly **27**: 177–182. Au 1928.

Thériot, I. Mexican mosses collected by Brother Arsène Brouard. II. Smithsonian Misc. Coll. 81[1]: 1–26. *f. 1–9.* Au 1928.

New species are described in *Oreas* (1), *Coscinodon* (1), *Funaria* (1), *Bryum* (1), *Pilotrichum* (1), *Cyclodictyon* (1), and *Lindbergia* (1).

Thomas, H. E. Root and crown injury to apple trees. Phytopathology **18**: 547–551. Je 1928.

Tiedjens, V. A. The relation of environment to shape of fruit in *Cucumis sativus* L. and its bearing on the genetic potentialities of the plants. Jour. Agr. Res. **36**: 795–809. *f. 1–7.* "1 My" Au 1928.

Tiedjens, V. A. Sex ratios in cucumber flowers as affected by different conditions of soil and light. Jour. Agr. Res. **36**: 721–746. *f. 1–14.* "15 Ap" Jl 1928.

Van Hook, J. M. Indiana fungi-X. Proc. Indiana Acad. Sci. **37**: 365–371. 1928.

Wallace, R. H. Long time experiments with plants in closed containers. Bull. Torrey Club **55**: 305–314. *pl. 9+f. 1.* "Je" 2 Au 1928.

Waterman, A. M. Rose diseases: their causes and control. U. S. Dep. Agr. Farm Bull. 1547: 1–19. *f. 1–10.* F 1928.

Weatherby, C. A. A note on the genus *Paspalum* in New England. Rhodora **30**: 133–135. 24 Jl 1928.

Weber, G. F. Owen F. Burger—man and scientist. Plant Bd. Florida Mo. Bull. 12: 158–162. *portrait.* F 1928.

Werdermann, E. Die Blüte von *Ariocarpus strobiliformis* Werd. Zeits. Sukkulent. **3**: 306–307. 8 S 1928.

Weston, T. A. *Antirrhinum* disease. Gard. Chron. **84**: 229. 22 S 1928.

Weston, W. H., & Weber, G. F. Downy mildew (*Sclerospora graminicola*) on Everglade millet in Florida. Jour. Agr. Res. **36**: 935–963. *pl. 1, 2+f. 1–4.* "1 Je" S 1928.

Wherry, E. T. Northward range-extensions of some southern orchids in relation to soil reaction. Jour. Wash. Acad. Sci. **18**: 212–216. 19 Ap 1928.

Whetzel, H. H., & Jackson, H. S. The rusts and smuts of Bermuda. Trans. British Myc. Soc. **13**: 1–32. 26 Mr 1928.

Wherry, E. T. The history of the Franklin tree, *Franklinia alatamaha*. Jour. Wash. Acad. Sci. **18**: 172–176. 19 Mr 1928.

Wherry, E. T. Selecting a national flower. Jour. N. Y. Bot. Gard. **29**: 209–210. Au 1928.

White, O. E. Mutation, adaptation to temperature differences, and geographical distribution in plants. Verh. V. Internat. Kongr. Vererb. **2**: (Zeits. Indukt. Abst. suppl. **2**:) 1575–1586. 1928.

White, T. H. Importance of temperature in control of snapdragon "rust" (*Puccinia Antirrhini*). Florists Exch. **69**: 612–613. 13 O 1928.

Williams, R. O. Ranales. Flora of Trinidad and Tobago **1**: 1–22. 1928.

Williams, R. O., & Cheeseman, E. E. Rubiales. Flora of Trinidad and Tobago **2**: 1–48. 1928.

Williams, R. S. Mosses of Peru collected by the Captain Marshall Field Peruvian Expedition, 1923. Field Mus. Nat. Hist. Publ. Bot. **4**: 125–139. *pl. 1–10*. 31 My 1927.

Woodroof, N. C. Development of the embryo sac and young embryo of *Hicoria pecan*. Am. Jour. Bot. **15**: 416–421. *pl. 23–25*. Jl 1928.

Yuncker, T. G. Observations on the teratology of the genus *Cuscuta*. Proc. Indiana Acad. Sci. **37**: 335–338. *f. 1–25*. 1928.